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LIBRARY OF
BOSTON SOCIETY OF CIVIL ENGINEERS

No. 6319

GIFT OF

PURCHASED JUL 15 1908

RULES

Books and periodicals may be used in the Society rooms by members and friends.

Members may borrow books for home use—with the exceptions noted below—but no one shall have more than four books at any time, or keep any book more than two weeks.

Volumes belonging to a set—such as volumes of bound periodicals and of proceedings or transactions of societies—and such other books as the Board of Government may designate, may be taken from the rooms for a limited time only, by special arrangement with the attendant. They shall be subject to recall at any time.

There shall be no immediate renewal of any book on its return to the library.

A member borrowing a book shall at that time give a receipt therefor.

A fine of one cent per day per volume shall be charged for over-time, and must be paid before the delinquent can take any more books.

Hand books, indexes, current numbers or unbound files of periodicals, books belonging to the Clemens Herschel Special Library, and new books not yet placed on the regular shelves must not be taken from the rooms.

Books of unusual value are marked with a star (*), and must not be taken from the rooms, except by written permission from the Librarian, to be filed by the attendant.

Any person mutilating or losing a book shall pay for the damage, or replace the book.

Any one who violates the above rules may, upon written request from the Librarian to the Board, be debarred from the privileges of the library for less than three months, as the Board may determine.

(Revised June 16, 1915.)

9. 12.

3

SECTION.

DIVISION.

BOOK.

12

NINETEENTH
ANNUAL REPORT
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.,
DECEMBER 31, 1885.

BURLINGTON:
PRINTED AT THE OFFICE OF R. S. STYLES.
1886.



NINETEENTH ANNUAL REPORT

OF THE

~~WATER DEPARTMENT~~

With Compliments of

FRANK H. PARKER,

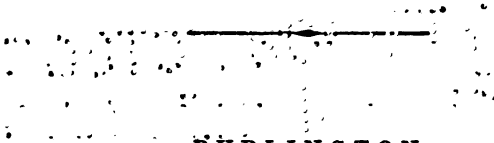
Please Exchange.

Superintendent.

CITY OF BURLINGTON, Vt.,

DECEMBER 31, 1885.

6319



BURLINGTON:

PRINTED AT THE OFFICE OF R. S. STYLES.
1886.

CITY OF BURLINGTON, VT.

Water Department.

1885.

WATER COMMITTEE.

Alderman ALGER, *Chairman.*
Alderman GOODELL,
Alderman WALKER.

SUPERINTENDENT.

F. H. PARKER.

COLLECTOR.

G. D. WELLER, *City Treasurer.*

PUMPING STATION.

JOEL W. THOMAS, *Engineer.*

ALFRED J. HOWARD, *Foreman.*

JOHN J. JIVO

FOREMAN.

WILLIAM CASSIDY.

REPORT

OF THE

SUPERINTENDENT OF WATER WORKS.

To the City Council of the City of Burlington:

GENTLEMEN :

The following is a statement of the receipts and disbursements of the Burlington City Water Works from January 1, to December 31, 1885.

RECEIPTS.

From G. D. Weller, City Treasurer....	\$19,663.28
---------------------------------------	-------------

DISBURSEMENTS—CONSTRUCTION.

Service pipes and fittings.....	\$ 513.73
Labor on services.....	490.76
Cast iron pipe, oakum and lead.....	2,011.02
Labor laying mains.....	1,070.79
Gates.....	177.42
Gate and cut-off boxes.....	177.31
Repair of tools.....	20.20
	<hr/> \$ 4,461.23

WATER DEPARTMENT.

C U R R E N T .

Pay rolls.....	\$1,154.62
Materials for management and repairs..	291.00
Office expenses.....	100.40
Printing, advertising and postage.....	61.23
Superintendent's salary.....	1,000.00
Horse-keeping, shoeing and repairs....	228.35
Filling wash-outs.....	56.78
Gate and cut-off boxes.....	400.33
Repair of hydrants.....	48.34
New wagon and harness.....	100.00
New safe for office.....	113.50
Repair of tools.....	32.58
Lowering and protecting services from frost.....	936.17
Incidentals.....	48.40
Replacing cement pipe {	Pipe..... 2,150.71
	Labor..... 1,574.25
	Lead, oakum and wood... 225.78
	Gates..... 266.83
	<hr/> \$ 8,789.27

P U M P I N G .

Pay rolls.....	1,968.71
Supplies.....	286.56
Fuel.....	2,626.14
Repairs to machinery.....	91.04
Repairs to buildings, &c.....	18.92
Rent of ground.....	150.00
Boiler insurance.....	90.00
Repairs to motor.....	206.89
Incidentals.....	10.70
	<hr/> \$ 5,448.96

M E T E R S .

Meters.....	891.93
Repairs, setting and freight.....	71.89
	<hr/> \$ 963.82

WATER DEPARTMENT.

5

RECAPITULATION.

Construction	\$4,461.23
Current	8,789.27
Pumping	5,448.96
Meters	963.82
	\$19,663.28

We hereby certify that we have examined the vouchers and accounts of the Superintendent of Water Works from January 1 to December 31, 1885, and find the same correct.

MICAH H. STONE,
GEO. W. BECKWITH, } Auditors.
D. A. BRODIE,

WATER PUMPED.

1885.	GALLONS.
January	14,486,025
February	19,231,650
March	17,481,775
April	15,879,150
May	19,657,925
June	21,339,800
July	19,455,075
August	19,066,075
September	17,770,000
October	16,064,525
November	13,864,075
December	14,730,250
Total water pumped 1885	209,026,325
“ “ “ 1884	218,119,850
Decrease in 1885	9,093,525

This is the smallest amount pumped in the last six years.

Average daily consumption, 1884	595,955
“ “ “ 1885	572,674

SERVICES.

There have been added 110 services of the following sizes :

3.....	4	inch pipe.
2.....	2	“ “
1.....	1½	“ “
1.....	1¼	“ “
8.....	1	“ “
4.....	¾	“ “
91.....	½	“ “

Five services have been discontinued, four of which are replaced by four of the above.

Twenty services on Pine street were disconnected from the cement pipe and attached to the 8 inch iron pipe.

MAINS.

New mains of four inch cast iron pipe have been laid in the following streets :

Maple street, westerly from Prospect to Summit street.....	423	feet.
Summit street, southerly from Maple street to hydrant.....	25	“
Mansfield avenue, northerly from Colchester avenue to Loomis street.....	1,045	“
Blodgett street, northerly from Strong street to Ward street.....	335	“
Interval avenue, northerly from Archibald street to North Bend street.....	1,169	“
North Bend street, westerly from Interval avenue to pipe laid in 1884.....	1,138	“
Strong street, continued westerly, connecting with North avenue pipe.....	20	“
Crowley street, easterly from North avenue....	300	“
Union street, northerly from College street, connected with 10 inch cement main by 24 ft. 1 inch pipe.....	228	“

Total length of new mains..... 4,683 feet.

WATER DEPARTMENT.

7

The cement pipe in the following streets has been replaced this season—

WITH 6 INCH CAST IRON PIPE.

Champlain street, southerly from Maple street...	723 feet.
Maple street, easterly from Champlain street to St. Paul street.....	844 “
Champlain street, southerly from Bank street..	204 “
St. Paul street, southerly from Maple street to Spruce street.....	1,296 “
Spruce street, easterly from St. Paul street....	48 “
Spruce street, westerly from Union street.....	20 “
South Union street, southerly from a point 165 feet north of Spruce street to Howard street.....	1,327 “

WITH 4 INCH CAST IRON PIPE.

Adams street, easterly from St. Paul street.....	43 “
King street, easterly from St. Paul to Church street.....	400 “

Total length of cement pipe replaced.... 4,905 feet.

TABLE OF PIPE NOW IN USE.

Size	10	8	6	5	4	3	2	1½	1¼	1	¾	½	Total.
Cement..	7262	.....	12272	2504	57564	21308	.....	.....	.....	.....	.....	.....	100,905
Iron.....	7848	10731	9071	.....	14626	2600	1346	900	240	1260	1205	785	50,612

Total feet pipe..... 151,571

Total miles pipe..... 28.7

HYDRANTS.

The following hydrants have been removed this season :

LOCATION.	KIND.
Champlain street, south end, under lumber shed.....	1 Nichols Post.
Champlain street at gate to marble mill.....	1 “ Branch
Champlain and Maple, s. e. corner.....	1 “ “
St. Paul and Maple, n. w. corner.....	1 “ “
St. Paul and Spruce, n. e. corner.....	1 “ “
Union and Howard, n. w. corner.....	1 “ “
Church, at King, east side.....	1 “ Post.
Total removed.....	7

The hydrants set this season are located as follows :

Summit and Maple, s. w. corner.....	1 Lang Post.
Mansfield Ave. and Loomis St. s. w. corner.....	1 “ “
Champlain street, west side, opposite Bobbin Shop.....	1 “ “
Champlain street, west side, opposite yard to Marble Mill.....	1 “ “
Champlain and Maple, s. w. corner.....	1 “ “
St. Paul and Maple, s. w. corner.....	1 Nichols “
St. Paul, west side at Adams.....	1 Lang “
St. Paul and Spruce, n. e. corner.....	1 “ “
Union and Howard, n. w. corner.....	1 “ “
Church and King, n. w. corner.....	1 Nichols “
Total set.....	10

The number of private hydrants mentioned in last report should have been 21, one of which was removed this season, making the present number.....20

Public hydrants 138, with six removed and ten added.....	142
Total hydrants in use.....	162

GATES.

The following gates on old cement pipe have been removed:

Champlain, opposite Marble Mill.....	1.....	4 inch.
Maple, at Champlain.....	2.....	3 “
Maple, at Pine.....	2.....	3 “
Pine, at Maple.....	1.....	6 “
St. Paul at Adams.....	1.....	4 “
Adams, at St. Paul.....	1.....	4 “
Spruce, at St. Paul.....	1.....	4 “
Spruce, at Union.....	2.....	4 “
Union, 150 feet south of Spruce.....	1.....	4 “
Total removed.....	12	

The following gates have been set this season :

Maple at Prospect.....	1.....	4 inch.
Mansfield avenue at Colchester avenue.....	1.....	4 “
Maple at west line Champlain.....	1.....	6 “
Maple at east line Champlain.....	1.....	6 “
Maple at west line Pine.....	1.....	6 “
Maple at east line Pine.....	1.....	6 “
Maple at west line St. Paul.....	1.....	6 “
St. Paul at north line Adams.....	1.....	6 “
St. Paul at south line Adams.....	1.....	6 “
St. Paul at north line Spruce.....	1.....	6 “
Adams at east line St. Paul.....	1.....	4 “
Spruce at east line St. Paul.....	1.....	6 “
Spruce at west line Union.....	1.....	6 “
Union 165 feet north of Spruce.....	1.....	4 “
Union at north line Spruce.....	1.....	6 “
Union at south line Spruce.....	1.....	6 “
Union at north line proposed street, north of Adams school.....	1.....	6 “

Union at south line of do.....	1	6 inch.
Union at north line Howard.....	1	6 "
King at east line St. Paul.....	1	4 "
King at west line Church.....	1	4 "
Crowley at east line North avenue.....	1	4 "
Strong at east line North avenue.....	1	4 "
Blodgett at north line Strong.....	1	4 "
Interval avenue at north line Archibald.....	1	4 "
North lumber yard, opposite Oil Tanks.....	1	6 "
Union at St. Paul.....	1	4 "
Pine at B., W., D. & Co.'s Mill.....	1	8 "
Total added.....	28	

TABLE OF GATES NOW IN USE.

Size.....	10	8	6	5	4	3	2	1½	1¼	1¾	Total.
	14	13	39	51	133	53	41	11	3	23	251

CURRENT.

The repairs made during the year have been as follows :

On cement pipe.....	31 breaks.
" " ".....	4 leaks.
" " ".....	1 pick hole.
" iron ".....	4 breaks.
" " ".....	6 leaks.
" service ".....	27 "
Hydrants broken off by frost.....	2
" ".....	4
Gates ".....	1

The unusual number of breaks and leaks are accounted for in part by the severity of last winter. The mains in some streets and very many service pipes remained frozen for three to four months. To avoid this trouble in the

future 250 services and 5 hydrant branches have been lowered, and protected from frost, by boards and shavings. There have been set this season 144 iron stop boxes, 37 iron gate boxes, 152 wooden stop boxes, 4 wooden hydrant boxes.

PUMPING.

The amount of water pumped is the smallest in the last six years, although we have added 408 service and gained 2,000 in population in that time. This can be accounted for partially, by the number of frozen services last winter, and the frequent rains during the summer, but is largely owing to the use of meters and the care taken in preventing the reservoir from overflowing.

Shavings have been used for fuel ten months, and the pumps have been run nights for six and a half months, and during the hot months seven nights per week, to prevent, as far as possible, the alternate wetting and drying of the reservoir slopes.

The pumping station is about in the same condition as previously reported, and it will be a matter of regret if something is not done in the near future to make its appearance and surroundings more creditable to the city.

METERS.

There are in use at present 239 meters, again of thirty-two over last year. Of this number 190 are owned by individuals, and 49 are the property of the city. The amount of water registered by these meters has been 28,622,599 gallons, the bills for which amount to \$6,672.17. About 14% of the water pumped is used through meters, yielding 23% of the total amount collected.

The use of meters is each year increasing among the best managed water departments in this country, and the

opinion is gaining ground that the fairest and most equitable way of selling water is obtained by their use.

RECOMMENDATIONS.

I would earnestly recommend a liberal appropriation toward replacing the cement pipe in the lower parts of the city. Streets have been torn up, sewers demolished, and the cellars to several houses have been filled with water and mud during the year, by the bursting of these pipes, until no one can feel secure from similar annoyance, if they are so unfortunate as to live on a street in which there is a cement water pipe.

The past season six inch pipe has been substituted mostly for three and four inch cement pipe, but when the mains in the north part of the city are replaced, pipes of much larger size should be used, in order to obtain effective fire pressure.

That there may be some system about this work, a plan should be adopted regulating the sizes of pipes to be substituted in the various streets.

The criticism is frequently made that the affairs of the Water Department do not get the attention they should from the Water Committee, owing to the large amount of other business coming before the Board of Aldermen, which is enough to demand what time and attention they can spare from their private business. Most water departments are managed by three or more Water Commissioners, the term of office of one only expiring each year. This could be accomplished here by a charter amendment, and the affairs of the department would then be kept in experienced hands, familiar with its needs and aims, and not frequently entrusted to three inexperienced men, who are so fortunate as to be elected Aldermen, for the first time.

The following statistics suggested by the New England Water Works Association are appended as part of this report.

Respectfully submitted,

F. H. PARKER,

Superintendent.

Summary of Statistics

SUGGESTED BY THE

NEW ENGLAND WATER WORKS ASSOCIATION.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by city census of 1885, 13,357.

Works constructed 1867-8.

Owned by City.

Source of supply, Lake Champlain.

Mode of supply,—pumping.

PUMPING.

1. Builders of pumping machinery,—H. R. Worthington.
2. Description of fuel.

{	<i>a.</i> Anthracite. <i>c.</i> Grate. <i>d.</i> Pittston. <i>e.</i> \$4.05. <i>g.</i> Mill shavings	} 7 weeks. } 45 weeks.
---	--	---------------------------
6. Total pumpage for year, 209,026,325 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.

Cost of pumping figured on pumping station expense,

\$5,448.96.

11. Per million gallons raised against dynamic head into reservoir, \$26.07

12. Per million gallons raised one foot high (dynamic),
\$0.0824.

Cost of pumping figured on total maintenance,

\$28,932.23.

13. Per million gallons raised against dynamic head into Reservoir, \$138.41.

14. Per million gallons raised one foot high (dynamic),
\$0.438.

FINANCIAL.

Receipts.	Maintenance.	Expenditures.
Division I.		
From Consumers :		
A. Water rates, domestic.	\$24 347.27	AA. Management and repairs.
B. " " manuf'n'g.	2,487.55	BB. Interest on bonds.....
C. Net receipts for water.	26 834.82	CC. Total maintenance for y'r.
D. Misc., coal and grass..	797.27	DD. Balance—to City Treasury.
E. Total	\$27,632.09	
From Public Funds.....		
F. Hydrants.....	1,900.00	
G. F'n'tns & parks	75.00	
H. Wat'ring troughs	250.00	
I. Public buildings.	124.00	
	1,649.00	
K. Gross R'c'pts all sources	\$29,281.09	EE. Total.....
		\$29,281.09

Division II.

From fixed rates	{ L. Domestic	\$19,876.86
	{ M. Manufacturing	285.79
	N.	\$20,162.65
From meter rates:	{ O. Domestic	\$ 4,470.41
	{ P. Manufacturing	2,201.76
	Q.	\$6,672.17

CONSTRUCTION.

R. From balance of previous year,	\$1,700.58	FF. Extension mains,	\$3,300.00
T. " appropriation from tax levy,	2,396.04	GG. " services,	1161.23
U. " pipe and labor,.....	364.61		
V. Total.....	\$4,461.23	KK. Total.....	\$4,461.23

W. Net cost of works to date.....\$511,340.13

*X Bonded debt at date..... 244,900.00

†Y. Value sinking fund at this date.. 89,404.93

Z. Rate of interest 6%.

* \$150,000 to be refunded in 1886.

† Toward paying total bonded debt
of City of.....\$439,900.00.

CONSUMPTION.

1. Estimated total population at date, 13.357.
2. " " on lines of pipe at date,
13,000.
3. Estimated population supplied at date, 12,700.
4. Total number gallons consumed for year, 209,026,325.
5. Passed through domestic meters, 16,885,023 or 8.7%.
6. Passed through manufacturing meters, 11,737,576, or
5.6%.
7. Average daily consumption, 572,674 gallons.
8. Gallons per day to each inhabitant, 42.8.
9. Gallons per day to each consumer, 45.
10. Gallons per day to each tap, 267.

DISTRIBUTION.

MAINS.

1. Kind of pipe cement lined, cast iron, wrought iron,
2. Size, from $\frac{1}{4}$ inch to 10 inches.
3. Extended 9,588 feet,
4. Discontinued, 4,905 feet.
5. Total now in use 28.7 miles,
6. Cost of repairs per mile, \$35.
7. Number of leaks per mile, 1.5.
8. Small distribution pipes, less than 4 inches, total length, 30,449 feet.
9. Hydrants added, 3.
10. Number now in use, 163.
11. Stop gates added, 28.
12. Number now in use, 251.
13. Small stop gates, less than 4 inches, total 67,
14. Number of blow-off gates, 4.
15. Range of pressure on mains at centre for day and night, 70 to 85 lbs.

SERVICES.

16. galvanized iron, lead.
17. from $\frac{1}{4}$ inch to 4 inches.
18. 2,389 feet.
19. 143 feet.
20. 11.8 miles.
21. Service taps added, 110.
22. Number now in use, 2145.
23. Average length of service, 29 feet.
24. Average cost of service \$10.64.
25. Meters added, 32.
26. Number now in use, 239.
 - a. domestic, 203.
 - b. manufacturing, 36.
27. Motors and elevators added, 1.
28. Number now in use .5.

REPORT
OF THE
WATER COMMITTEE
OF THE
City of Burlington, Vt.,
UPON THE CITY WATER SUPPLY,
TOGETHER WITH
ANALYSES OF VARIOUS WATERS
OBTAINED BY THEM,
FROM COMPETENT CHEMISTS.
FEBRUARY, 1886,

WATER COMMITTEE.

Alderman C. J. ALGER, Chairman.

Alderman J. W. GOODELL,

Alderman HIRAM WALKER.

SUPERINTENDENT,

FRANK H. PARKER.

R E P O R T.

To the City Council :

GENTLEMEN :

The Water Committee of the City of Burlington respectfully report upon the City Water supply and other matters connected therewith, which have been referred to us, as herein stated, with historic details, as follows.

That in January, 1884, the City Health Officer alluding to this subject made this statement. "First in the list of improvements by which the public health would unquestionably be benefited, is the extension of the water main to some point outside the breakwater. The present water supply is drawn from a point north of all the sewers and close to the docks where it is contaminated by the sewage which our strong south winds constantly sweep along in that direction, and by the filth from the docks. Nine years ago a chemical analysis of water taken from near the mouth of the main pipe was made by the professor of chemistry of the University of Vermont at the request of the Health Officer. The analysis showed the presence of a grain of organic matter in a gallon of the surface water, and twelve grains in a gallon of water taken from near the bottom. This amount of organic impurity, which is sufficient to render the water dangerous for drinking purposes, has since then undoubtedly increased rather than diminished, with the construction of new sewers and consequent increase in the volume of sewage. It can hardly be doubted that much of the diarrhoeal trouble so common in Burlington, is due to the condition of the

City water supply. To extend the water main beyond the breakwater would be to take it beyond the reach of contamination and give our citizens a supply of pure water”.

The Mayor in his message in April, 1884, called special attention to the statement of the Health Officer and expressed the hope that the Board would take the matter into consideration.

So much of the Mayor's message as related to the Water Department was referred to the Committee on the Water Department at a meeting of the Board of Aldermen held on the 12th day of May, 1884.

The attention of the public had before this on various occasions been called to the character of the water supply, and in view of this, the Committee when they came to consider the matter deemed it wise to recommend a thorough examination and investigation of the whole question of our City water supply, and they accordingly reported to the Board June 9, 1884, substantially as follows—as a preliminary report on which the Board could take such action as should seem advisable, viz. “That we had carefully considered the same (the Mayor's suggestions as to the extension of the mains for the water supply) and find the following facts. That though there is a general sentiment in the City that the water taken from the breakwater would be better than that taken from the present pumping station, there is no proof that such would be the result. That this sentiment may have been fostered by items from time to time in the press of the City, and by private discussion on the part of persons possibly interested in bringing about a contract for such extension and expenditure. Before any such considerable expenditure is made we would advise careful analysis to be procured of several specimens of water

taken from the respective points during both summer and winter months. The expense of such analysis is comparatively small. We recommend then that the chairman be authorized to procure such specimens and analysis, the chemist not to be made aware of the location from which the specimens are taken, etc. After such scientific tests have been made, if the drinking quality of the water from the proposed station shall be found to be materially better than that from the present station, there would probably be no objection from any source against the proper expenditure for such extensions of the mains.

“Pending such scientific tests, it is proper to say there are those who doubt that there would be any improvement made by the expenditure, and for these reasons. The motion or tendency of the water through the lake is to the north, and that though this is so, the general tendency of the water past the pumping station at the depth from which the water is taken is southerly, even against a moderate south wind. Fishermen along the shore near the station, and others have noticed that their lines at the bottom would float south of the place where they were thrown in, while at the top they would tend north in south wind. The pumping station in fact was selected in part by reason of this known tendency. In one of the reports made before the location of the pump house was decided upon, or rather before it was decided whether we should get our water supply from the lake or from the Winooski river, we find the following statement,—it is McAlpine’s report,—‘It is said that the drift both at the surface and along the bottom of the lake near the shore in front of the City is almost always southerly, and this has determined the location of the works at the north end of the City.’ The main lake current is from south to north, and that portion of it

flowing east of Juniper, strikes against Rock point, and is turned back and eddies back inside the bay past the pumping station, and when the south wind is strongest the undercurrent thus eddying back is stronger than when we have a north wind. The sewage of the City passes into the lake principally at the southerly portion of the bay and is there taken by the current and passed out around the south end of the breakwater and carried along the west side of it into the main lake channel.

“ Mr. D. C. Linsley in his report, in 1866, referring to the claim then made that sewage might at times affect the quality of the water taken from the point where our present pumping station is located, said ‘this claim may without danger be disregarded in view of the fact that some thousands of feet of close dockings, backed with earth, project directly into the lake, to cut off this anticipated drift of sewage matter, and that all the vessels in the harbor and hundreds of our citizens residing in the vicinity, or engaged in their various business pursuits along the docks, and in the shops and offices in the vicinity, have used the water daily and constantly for years without experiencing the threatened difficulty.’ During the past year the City has expended over \$3,000 in extending southerly a sewer pipe south from Maple street, that the discharge of sewage might enter the lake as far south as possible, and as soon as Battery street sewer is completed, the small amount of sewage discharged at the foot of College street will be carried to the same south point. Thus, within a year or two we may safely conclude all sewage will be discharged at the very southmost portion of the bay, more than a mile distant, measuring by the irregular frontage of the wharfage from the pumping station, and the oxidation caused by beating along this irregular

frontage for such a distance in strong south winds, (if it moved in that direction) would largely tend to purify the water, even if it was not the known and established course of the water to run in the opposite direction. The quantity of sewage discharged is as yet small, and turned into a stream fifteen hundred feet wide and fifteen feet deep on one side, and thirty-five feet deep on the other side, cannot be very dangerous, especially as the water used is taken over a mile up stream as it were, from where the discharge is made.

“Again, the annual statistics given by our Health Officers do not tend to confirm the theory that our water supply is really an unhealthy one. Sewage in drinking water naturally tends to produce typhoid fever, and yet typhoid fever does not come from sewage only. Statistics hitherto have shown but a limited number of cases in any one year. In 1878, when we had an attack of sentimentality as to extending the pipes to the breakwater, the Health Officer, (Dr. H. H. Atwater,) made some judicious and candid remarks as to this subject, from which we quote as follows: ‘In my observations of the diseases of the City, and their causes, during the period from the introduction of public water supply to the present time, I have been unable to trace any distinct ill effects from the present source of supply. Typhoid fever, the disease which of all others we should expect to result from sewage contamination of drinking water, is of infrequent occurrence in this community. There has been only one death from this disease during the last year, (1878), and this of a man over 70 years of age. Diarrhoea and dysentery occur here sporadically and are not virulent, and prevail mostly during the summer months, so that they may more reasonably be attributable to the debilitating influence of heat, over-exertion, and other causes than to impure drinking water.’

"These facts, theories and opinions are given to show that there is no apparent danger to the health and safety of the City, so great as to prevent our careful investigation of the matter during the ensuing year. All which is respectfully submitted."

This report was accepted and ordered on file, and the recommendation approved, and the committee was directed to pursue the investigation in accordance with the recommendation therein contained.

This report, as above given, the City did not order to be published, and the papers here disposed of it with a single sentence, all that seemed to them necessary to give as news, to the effect that the Committee did not know of any proof that water at breakwater was better than at pumping station, and doubted if it was any better. That report is given here that the *history* of the matters, as the case has progressed, might be read by any who are curious to follow the case in its details.

While the Committee thus had this whole matter under consideration, a monster petition was gotten up signed by 575 persons, including many of our most prominent, cautious and deliberate citizens, as well as heaviest tax-payers, worded as follows:—

To the Mayor and Board of Aldermen of the City of Burlington.

Gentlemen :

The recent epidemic of fever which has prevailed here in such an unexampled manner shows clearly that the sanitary condition of our City is defective in some important point. It is the opinion of the medical profession that the defect can be traced to the water. It is also their opinion that a much purer supply of water can easily be obtained by extending the supply pipes so that the water shall be taken from outside the breakwater.

Your petitioners believe that at present the water is liable to contamination from the sewerage and drainage of the city, from the refuse and filth of the large number of canal boats and other boats

lying at our wharves, and from the deposit in our harbor when disturbed during the prevalence of strong westerly and southerly winds.

We believe that the prospect of the prevalence of cholera another season, if not this, demands immediate action, in order that we may be protected from it as fully as possible.

We believe that the cost of extending the supply pipes will be less than the cost of the sickness directly traceable to this cause for this season alone.

We believe that our citizens, and that strangers coming here, have lost confidence in the purity and healthfulness of our water supply, and that it is of utmost importance to the growth and prosperity of our City that confidence should be regained.

We believe that if water is obtained from beyond the breakwater it will be pure and healthful. Therefore, we, your petitioners, pray that your honorable body will take immediate action in the matter *and in such a manner that the whole expense of the extension shall be provided for by taxation on the grand list of the City and not by any charge upon or increase of rates against the users of water.*

This petition was not presented in the usual quiet way, but a special Committee was appointed at a public meeting called for that purpose, to present it, and they applied to the Board for a special meeting for receiving and hearing what might be said thereon, and August 11th was fixed for that purpose, at which date a full presentation was made, and various witnesses questioned, and medical men gave their views, and Senator Edmunds and Hon. Edward J. Phelps were heard on the question.

This petition was referred by the Board of Aldermen to the Water Committee to investigate, in connection with the matters before referred to them as herein stated.

This reference broadened our work materially, and placed additional responsibilities upon us. It was in certain ways placing upon us the duties of the Health Department, —and we were to determine at once if there was reasonable grounds for supposing the few cases of typhoid fever we had so far had during the season, were to any considerable extent caused by the bad waters used here for domestic purposes. Looking up Medical Authorities and Health Reports we found there were more theories than facts to bear out the opinion of the petitioners in respect to this matter. We

applied ourselves first to a study of the facts as developed by the petitioners, and to the known statistics of the City and Country, and found that during the months of May, June and July, to which reference was made, the statistics for that time showed the following facts, and that from them there would seem little cause for alarm.

Our Health Officer's reports for these three months of 1884, had then just been published, and taking them we made a table for comparing them with like statistics for four previous years as follows.

Table of deaths in Burlington, 1880 to 1884, inclusive, for months of May, June and July:—

	1880.	1881.	1882.	1883.	1884.
May,	15	16	15	17	13
June,	19	14	29	18	17
July,	27	32	25	31	31
	—	—	—	—	—
Totals,	61	62	69	66	61

Measured by the death rate, our City then had been as healthy during the three months named as it had been during same months for several years, even if the population had been stationary, instead of having considerably increased, as was then claimed, and as our late census has assured us of. As the increase had been in all about equal to 15 per cent., the death rate for the three months of 1884 might have been 15 per cent. higher than in 1880, without causing alarm. This would have brought our deaths for those "epidemic" months, up to 70 against 61 in 1880.

Another table was made by full years, showing our standing in respect to typhoid fever.

Whole number of deaths

			No. Typhoid.
For the year,	1883,	242.	1.
" " "	1882,	254.	6.
" " "	1881,	226.	2.
" " "	1880,	219.	3.
" " "	1879,	228.	2.
		<u>1169.</u>	<u>14</u>

This showed that each 83d death in our City was placed to credit of typhoid fever. These tables, however, only go to show that at worst we are highly favored here in respect to this disease. It is however quite surprising that a people supposed to be feeding upon the very material that breeds this disease, a contaminated water supply, should have less of it than a sparsely settled community, supplied by the streams and pure springs of our Mountain State.

The last State registration reports then published, 1877 to 1880, inclusive, gave total deaths 20,442, and typhoid deaths 537, for the full four years, or one to every 38 to the credit of this disease. The United States census taken in 1880, gave typhoid fever credit for every 33d death throughout the land. For five years, then, not including the year 1884, typhoid in this City was credited with this number of deaths.....14

If we had as many as the State averaged we should have had in five years.....38

If we had had as many as the whole United States averaged, we should have had in five years.....42

If we had included above the year 1884, as we are now able to do, the deaths for that year, (238), and typhoid deaths too, (10), we should have had 1407 deaths, 24 of which would have been to the credit of typhoid fever—aver-

aging 1 to every 58 for six years—and at that rate we would have had for five years 20, in place of the 14 above given.

We do not undertake to solve the mystery of 1884 ; it is a question for the doctors, why we had more than twice the average number of such cases.

At the time the petition in question was circulated, there was no doubt a strong fear in the minds of some that there might be an epidemic coming that would prove severe, but since there has been so little of it comparatively, probably but few of our physicians would now express the opinion as to the origin of the disease that the petition expressed. Some even of the physicians at the time told us that they signed more for an investigation than because they fully believed in the alleged cause there stated.

Then, again, we have taken pains to write to other towns to inquire as to their condition in 1883 and 1884, in respect to this disease, and find they vary from year to year as much as we do. We wrote to St. Albans, St. Johnsbury, Montpelier, Waterbury, Rutland, Middlebury, Vergennes, etc. They however had no “contaminated” water supply like ours to feed upon that they could lay the disease to. (In 1885 the Health Officer tells us there has not been a single death reported in the city from typhoid fever, and not a case of sickness therefrom.)

These facts seem to throw doubt upon the alleged origin or cause of the disease or epidemic in 1884.

Again, we ought to feel renewed confidence in the safety and purity of our water supply after having had such a number of cases of typhoid fever as we unquestionably had. If there had been any connection between the sewage of the town and the pumping station, we should have had, according to all past history of such contamination, a very large number of cases—some hundreds, at least. This

contamination that passed into the sewage then could not have reached the station, or was purified before it reached that point by beating along the docks, or by other means that we do not yet comprehend.

It must be evident we think to all that we are not exposed to the dangers some feared we were. Again however, there are authorities many and strong, that scout the idea that this disease ever comes as an epidemic from contamination, except as connected with wells rather than with flowing streams, or large open basins or lakes. We have not thus far found reported a single case of such epidemic—unless Plymouth, Pa., be such an one, and of that we can only say, that as yet from all the exaggerated and contradictory statements in the papers, we do not know what disease afflicted that people, or its cause or origin.

The result, then, of our examination of the question presented by this petition, was not to confirm us in the views of the petitioners, that the exigency of the situation demanded immediate or rather hasty action, and did not show that so far the City health had been specially bad, but that the death rate by some means was lower than for some years during these same months, notwithstanding the population had increased to some considerable extent during those years. On further investigation we found that so far as death rate was concerned the average for this disease for the whole State, was quite above our higher rate for the same months, and this, too, notwithstanding the fact that we were almost the only population that had a contaminated water supply, as was claimed, which was furnished to the whole City. It was true that we had had more than our usual deaths from this disease, and that the disease had for some reason proved more fatal than in other localities is the

custom. Twenty cases of typhoid sickness were reported the whole season to the Health Officer, and of these ten proved fatal, 50 per cent. while usually only about 10 per cent. prove fatal. Perhaps we have so far been exempt from this disease in years past that our physicians did not grapple with it with their usual skill.

We early took occasion to communicate with a celebrated Health Department officer, who had stood at the head of the department in a neighboring State for several years, while investigations were being made in respect to this very disease, and who is referred to in a dedication of a work on sanitary matters, in these words; (to Dr. Henry I. Bowditch, whose early persistent and enthusiastic labors make him the apostle of sanitation in America). We applied to him to come here and look over the matter of our water supply and our epidemic, so-called, and gave him the facts and circumstances as to our water supply and the epidemic. We were unable to secure his attendance, but secured indirectly from him an opinion which he endorsed—that our method of disposing of our sewage was bad, but not the worst in the country. We were cited Turner's Falls, Mass., where the water supply was taken from the river from a point below where the sewage was turned into the river, and where thus far no injury had resulted to the general health. We also got this statement: "It is impossible to state with any certainty the cause of typhoid at any time, and it would seem to me hardly probable in so large a community as Burlington (20,000) that the public water could be the cause or even the vehicle for spreading the disease, unless the zymotic patients number at least some hundreds."

Though he was in considerable error as to our population—having added to it some 40 per cent., at least—if we take away even half of the number of cases, as we nearly

do, of the population, we are left with half of "some hundreds,"—half of more than one hundred, that should be expected from such contamination if it came from the water supply.

We found, too, that these investigations in Massachusetts developed two theories as to the origin of this disease, or three in fact, one called the English, that it came from contaminated water taken into the system, etc., and one that it came from a still larger and more constant stream of contamination—a stream of foul air taken into the lungs at least twenty times a minute for weeks and months. Burlington is filled with this kind of contamination—the open sewer from St. Paul to Pine street in the Fifth Ward, closed up this past fall, was, and ought to have been, an indictable nuisance, and so, too, is the old sewer running under houses and through gardens on the west side of St. Paul street, from King street to Maple street—whose track it would seem has been marked by a series of deaths of little folks from zymotic diseases in that row of houses on one side of one square, where there have died, within a few years, of diphtheria, a child of Hon. Henry Ballard, one of C. P. Frissell, Esq., one of Mr. Hatch, and lately another of Mr. Boardman's, and others, perhaps, that we do not recall.

The third theory held by Dr. Pettenkofer of Germany, is that the cause of typhoid fever was to be found in the soil, not in the water of the soil, which is regarded simply as an index like the face of a clock recording changes going on behind it, and that fever seed or germ is the result of "organic processes" taking place in the earth and communicated to man through the medium of the air. What these changes are or in what the fever germ consists are unexplained.

These views have met with great opposition in Eng-

land, where belief in the contamination of drinking water by animal excrement is very generally accepted as the chief causes of typhoid fever.

Dr. Bowditch, further along in his report for 1871, says "the theory that the disease comes from drinking water, that, in reading the reports of typhoid epidemics, occurring in England of late years, so far predominates over all other imaginable causes that we are led to believe either that the English drinking water must be exceptionally dirty or medical observers are unconsciously influenced by preconceived opinions, based upon the ingenious speculation of men of ability, who have directed their attention to this form of danger."

"In the great majority of cases in Massachusetts in which causes can be traced, *air* and not water, must be regarded as the vehicle." Finally he closes with this statement: "The single, continuous thread of probability which we have been able to follow in this inquiry, leads uniformly to the *decomposition of organized* (and chiefly vegetable) *substances* as the cause of typhoid fever as it occurs in Massachusetts."

There are other theories that some give credence to, that would look to other sources for development of these diseases—but filth, after all, seems to be most widely credited with these results, especially filth suppressed—fermenting, stagnant decomposition of vegetable and animal matter.

Having settled in our minds the question that it would be safe to *deliberate* and consider this question, we commenced the original work assigned us.

In June we had received from Prof. Sabin, of University of Vermont, the following letter, which we give as a part of the history of the case, and also as showing his pre-

conceived opinion of our water supply, and his idea of the value of chemical analysis.

BURLINGTON, VT., June 8d, 1884.

Mr. C. J. ALGER,

DEAR SIR :

In reply to your letter of May 29th, I will say that if anything can be done toward getting the water supply from beyond the breakwater, I am willing to make the analysis at a merely nominal price. It is to be observed that we have in the open lake the purest natural water I can learn of, and the samples from near shore will probably analyze well as compared with the supply of many other cities, but there will probably be a difference when compared with the water outside the breakwater. You will find an analysis of water taken from the water supply at our laboratory in one of the numbers of the "Cynic," in the first part of this year, made by Mr. Stiles, which is reliable I believe, and shows the Winter supply to be good.

A chemical analysis does not necessarily determine the fitness of water for use.

Very truly yours,

A. H. SABIN.

When we were ready to go forward with the analyses, we found he desired to take the samples himself, but we insisted upon his analyzing samples without knowing from whence they came. This he finally consented to do, but would not give us opinions on the water analyzed,—merely the figures. Before, then, sending off samples, we had to determine whether or not an analysis was of any value. We wrote Prof. Witthaus, to know "whether a chemical analysis does or does not necessarily determine the fitness of a water for use," and received this answer:

"I will answer your question with an unqualified affirmative. I am investigating the water supply of Buffalo, old and new, and have not the slightest hesitation in ordering wells closed, on information obtained entirely by chemical and physical analysis."

We afterwards put the same question to Prof. W. R. Nichols, of the Boston Institute of Technology, and got a cautious answer to the effect that science in such matters was glad of any external aid.

Prof. Seeley of Middlebury College answered the same question as follows :

"A chemical analysis is the accepted method of determining the fitness of water for use. We must rely upon this until we find something better."

We found as we proceeded in the investigation that some chemists had faith in their own works and others had not.

Prof. Sabin consented however to making the analyses, giving us the figures, without knowing the place from whence the samples were taken, without giving, however, opinions on the fitness of the samples for use as the others did.

We sent samples to Prof. Sabin, marked I, II, III,—samples which we expected were as poor as any water we ever use. The first was from the reservoir itself, on Monday, when it was as old as it ever would be, having had no fresh water mixed with it for 48 hours. II was from pipes corner of Elmwood Avenue and Spring Street. III was from mouth of suction-pipe at pumping station. Somewhat later we took him samples, VI, VIII, XI, XIII. These were taken in a strong south wind, when, if ever, we expected the contamination in the lake would show itself pretty clearly,—VI was the proposed breakwater station, to which the public had indicated their desire to have the suction main extended,—the west face of the breakwater, 10 feet south of the north end 10 feet deep. VIII was surface water from a point midway from the mouth of the sewer to the south end of the breakwater,—where ice had usually been gathered for our summer use. XI, was from Mark's Bay, 58 feet deep. XIII, was from carefully melted ice, taken from one of the City ice carts.

The following report was received :—

BURLINGTON, Vt., Oct. 30th, 1884.

MR. C. J. ALGER,

MY DEAR SIR :

I take pleasure in sending to you my report of the analyses of the seven samples of water submitted to me for examination. The analyses are as follows :—

	Free Ammonia. Parts per 100,000	Albuminoid Ammonia. Parts per 100,000	Chlorides. Grains per gal.	Total Solids. Grains per gal.
I.	.0093	.0168	3.5	9.
II.	.0040	.0180	5.	11.5
III.	.0160	.0160	1.1	2.5
VI.	.0060	.0114	3.	8.3
VIII.	.0040	.0072	2.5	7.
XI.	.0048	.0100	2.5	7.5
XIII.	.0075	.0176	1.8	4.2

It is not worth while to estimate the degree of hardness of such water which never has any considerable amount of lime in it. The only thing of importance is the ammonia, especially the albuminoid ammonia. The amount of this which is regarded as harmful, or rather as indicating danger, I have already stated in a previous report.

Very respectfully yours,

A. H. SABIN.

After getting these analyses we reported to Professor Sabin the points from which these samples were taken and asked him for comments, and in lieu thereof he sent the following general remarks and extracts :

"The water analyses were made by Wauklyn's method, which is the one in most common use, and according to the general custom among chemists the amount of chlorine present may amount to five grains per gallon without causing suspicion. When the free ammonia exceeds .008 parts per 100,000, it almost invariably proceeds from the fermentation of urea into carbonate of ammonia, and is a sign that the water in question consists of diluted urine in a very recent condition (Wauklyn.) Albuminoid ammonia above .010 parts in 100,000 begins to be a very suspicious sign, and over .015 it ought to condemn a water absolutely.

It should be observed that it is not claimed by any one that water containing a much larger amount of nitrogenous matter may not be perfectly healthy, for milk or soup contains some hundred times this amount ; the nitrogenous matter itself is not regarded as the immediate cause of disease, but the cause of disease, whether it is a micro-

copic organism or a ferment, is found in company with nitrogenous matter. The latter forms, as it were, the soil in which the destructive agents flourish. Now, when the amount is as large as the limit just stated, it is commonly found to be accompanied by something which causes disease. What this something is, is not definitely known; and it may be present in water which would not be regarded by the chemist as necessarily dangerous. On this point I can do no better than to quote from the excellent report of the chief medical official of Great Britain. "Chemical demonstration of unstable nitrogenous compounds in water is a warning which, of course, should never be disregarded; but water which chemical analysis would not condemn may certainly be carrying in them very fatal seeds of infection." So also, Dr. Frankland, the chief government chemist in this kind of work in England, says: "It is not asserted that small quantities of sewage are always injurious; you might go on using it for years and it might not be discovered, and yet you might have some outbreak of disease in the place, which nevertheless might be connected with the use of that sewage water."

It naturally follows from the above that a chemist is not justified in giving an opinion that water is fit for drinking purposes unless he has made an examination or survey of the locality so as to know something of the history of the water; that, at any rate, is my own opinion.

A. H. SABIN.

At the time the last samples were taken for Prof. Sabin, we sent the following samples to Prof. Witthaus, (Sept., '84.)

IV. Mouth of suction pipe at Pumping Station.

V. Breakwater, 26 feet deep, N. W. Corner.

VII. " 12 " " " "

IX. Surface, midway from sewer mouth to south end of Breakwater.

X. Mark's Bay, 62 feet deep.

XII. From melted ice.

These samples were reported upon as follows :—

BUFFALO, N. Y., Sept. 23, 1884.

MR. C. J. ALGER,

DEAR SIR :—

I have analyzed the samples of water submitted by you with the following results :

Number.	Total Solids.		Chlorine.		Free Ammonia	Albuminoid Ammonia.
	In 100,000	Grains in U. S. gal	In 100,000	Grains in U. S. gal.	In 100,000	In 100,000
IV.	7.20	4.20	0.21	0.12	.0052	.013
V.	7.92	4.62	0.18	0.11	.0146	.017
VII.	8.42	4.91	0.15	0.09	.0026	.011
IX.	11.54	6.75	0.97	0.57	.0080	.018
X.	10.50	6.12	0.58	0.30	.0080	.010
XII.	5.58	3.26	0.48	0.28	.0066	.017

Which show that all of these waters are contaminated with organic impurity to an extent much greater than I had looked for in the waters of Lake Champlain. The fact that the amount of chlorine is low in every case goes to show that this contamination is due to vegetable substances and not to the more serious animal impurities. Taking all things into consideration I would rank these waters in the order of their excellence, beginning with the best, as follows : VII, X, IV, IX, XII, V. ; of these VII and X are fair, not excellent, IV and IX are suspicious, XII and V are bad.

Either VII or X would furnish a tolerable source of supply, could no better be obtained ; XII and V. should be condemned absolutely as unfit for human use.

Very respectfully,

R. A. WITTHAUS, M. D.

This report from Prof. Witthaus quite surprised us, and it does still, for the difference between the figures for the pumping station that he marks as suspicious, and the one that he calls fair, not excellent, it will be noticed is but trifling. We called his attention to the impurities referred to as "vegetable substances, and not the more serious animal impurities" and told him two samples were taken from same point at different depths and got this response :

BUFFALO, N. Y., Oct. 10, 1884.

MR. C. J. ALGER,

DEAR SIR :—Your letter of the 3rd inst., is to hand.

You understand me rightly as to the nature of the organic impurity in the waters ; it is of vegetable origin and is not the result of contamination with sewage, except possibly in V.

As to the relative merits of IV and X. The difference between them is by no means as well marked as that between V and XII on the one hand and the other samples on the other. As I consider the amount of albuminoid ammonia a much safer guide to the purity of waters, such as these, in which the impurity is vegetable, than the free ammonia, I give more weight to the difference between .010 and .013 than to that between .008 and .0052. Neither VII, X, IV, nor IX, is entirely above suspicion, the degree of which is in the order in which they are named, and the difference between any two neighboring numbers is not very great although that between X. and IV. is somewhat more than that between VII and X or between IV and IX. Hence the division which I made in my report, which was brief as you say, as it was intended only as a preliminary statement to you. When I shall have made analyses of the same waters again under different conditions of wind, &c, I shall be in better condition to make a more full and positive statement as to any differences that may exist between these samples.

Concerning the difference between the two samples taken at different depths at the same point I find nothing extraordinary.

Yours sincerely,

R. A. WITTHAUS.

Having this report we deemed it best to spread out for winter analyses and accordingly we sent samples in March to him from pumping station obtained by cutting a hole in the ice at the end of the suction pipe, and also from the break-water at 10 and 26 feet depths, as before, and from Mark's Bay, marked respectively XVIII, XIX, XX and XXI. A preliminary report upon these four samples read as follows: "XXI is best, XIX and XX are nearly alike with possibly a slight preference in favor of XX—XVIII. is the worst, but even it is better than any of the samples previously sent."

He was then told where all the samples came from.

The following report was soon after made, embracing all the examinations he had made and two letters of March 30:

When taken.	Mark.	Taken from.	Total solids in 100,000.	Chlorine in 100,000.	Free ammonia in 100,000.	Albuminoid am- monia in 100,000.
Sept. '84.	IV.	Pumping station, 10 feet deep.	7.20	0.21	.0052	.013
Sept. '84.	V.	Breakwater, 26 feet deep	7.92	0.18	.0146	.017
Sept. '84.	VII.	" 12 " "	8.42	0.15	.0026	.011
Sept. '84.	IX.	Surface where ice is obtained.	11.58	0.97	.0080	.013
Sept. '84.	X.	Mark's Bay, 62 feet deep.	10.50	0.58	.0080	.010
Sept. '84.	XII.	Water from melted ice.	5.58	0.48	.0066	.017
March, '85	XVIII.	Pumping station, (same as IV.)	8.90	0.11	.0034	.010
March, '85	XIX.	Breakwater, 26 feet deep, (same as V.)	7.60	0.10	.0034	.008
March, '85	XX.	" 10 " " (same as VII)	7.52	0.11	.0016	.008
March, '85	XXI.	Mark's Bay, (same as X.)	6.60	0.09	.0034	.005

BUFFALO, N. Y., March 30, 1885.

MY DEAR SIR :—

I should have much preferred that you had adhered to your original intention of putting definite conundrums to me in place of leaving me to flounder around as I have done.

I have no idea of what you want to know. I have not the remotest suspicion of where Marks Bay is, possibly it is near B. and is thought of as a source of supply, or possibly it is near St. Albans or Plattsburgh, and was only sent for purposes of comparison; therefore I have limited what I have said under 7, to the few words it contains. If Mark's B. be feasible as a source of supply it is certainly to be greatly preferred to any of the others in March and September; and if you are considering it in that light I would suggest that you send samples from there, from the pumping station and the 12 foot point at the breakwater as soon as the lake is free of ice; if not too late when it has just run. If the same relation be then found to exist there, I could recommend Mark's Bay unqualifiedly.

If you are limited to the breakwater points for a change of base, go slow; for you stand just as good a chance of making things worse as you do of bettering them.

Many thanks for your offer of other reports, I should like to see them when the whole matter has been definitely disposed of, but I prefer to base my opinion on my own work exclusively, not because I think it better than that of another, but because I know about it.

I shall be in B. about May 10th and will call upon you.

Yours truly,

R. A. WITTHAUS.

BUFFALO, N. Y., March 30, 1885.

MR. C. J. ALGER,

DEAR SIR :

I should have preferred in reporting upon your water supply to have responded to definite questions in accordance with your original intention. In default of such questions I am obliged to frame queries for myself, which may have no bearing upon the questions which you wish to solve.

From the sources of the samples I infer that the question to be determined is: How does the quality of the water at the present pumping station compare with that at the situation from which ice is taken, with that at the two points on the breakwater, and with that at Mark's Bay?

From the enclosed tabulation of the results of my analyses I feel justified in stating:

1. In passing upon these waters the items of "hardness" and "total solids" may be left out of consideration, they being in all the samples much below the permissible limits. Indeed the waters are all exceptionally soft.

2. The element of "albuminoid ammonia" is of the greatest importance, next "free ammonia," then "chlorine." A water yielding .010 albuminoid ammonia is to be looked upon with suspicion, and is to be condemned, if at the same time free ammonia and chlorine be high. A water yielding .015 albuminoid ammonia is dangerously contaminated.

3. A comparison of the water from the pumping station with that of the situation whence ice is obtained, is only possible in the case of the September samples, and in that case is in favor of the former.

The water from melted ice is of no value as indicating the composition of the water from which it was obtained. This is partly because, during the process of freezing, certain of the constituents remain largely in the unfrozen water, as is evidenced by the small amount of total solids, and low degree of hardness of XII; and partly because if suitable precautions be not very carefully had, the ice in melting rapidly accumulates organic impurity from the air. The high albuminoid ammonia and chlorine of XII, indicate that it had become so contaminated, unless indeed the ice was exceptionally bad.

4. The two breakwater samples differ some in September and in March, and the difference is in favor of the sample taken from the lesser depth in each case. The September sample from the greater depth is certainly and dangerously contaminated with sewage.

These differences at different depths, if the samples be taken at the same point, indicate a lower current, leading rather directly from some source of contamination which was in more active operation in September than in March. I do not think that the wind has any influence whatever at such a depth.

5. In September, and in March as well, the water at the shallower point at the breakwater is better than that at the pumping station. The water from the greater depth at the breakwater is, on the other hand, only slightly better than that at the pumping station in March, but worse beyond comparison in September.

6. While it may be possible to obtain a better supply from the breakwater than from the present station, the location of the inlet should be decided upon with great caution, and only after a series of examinations of water taken from the same points during every month of the year. Certainly the point from which samples V and XIX were taken should not be chosen.

7. The water from Mark's Bay is distinctly better than those from any of the other sources.

8. All of the March samples are markedly better than those taken from the corresponding points in September.

I am Sir,

Yours most respectfully,

R. A. WITTHAUS, A. M., M. D.

As before stated, we spread out considerable for our winter analyses, expecting to find more ammonia under ice than in the open lake. We also expected worse results from the breakwater than in the summer, for we recollected that the point where smelt fishing in former years has always been most successful was at the north end of the breakwater, at the greatest depth. We expected to find that the organic matter that drew them there was in the place where we got our worst samples in the fall, but both deep and shallow points were alike; but fishing at that point was a failure that winter. We communicated with the United States Fish Commissioner as to habits, etc., of these fish and learned that, in his opinion, these fish help to devour organic impurities and thus aid in the purification of the water, and gather where decaying organic matter is to be found. Their absence from that point last year is unexplained.

We sent four samples to W. R. Nichols, professor in the Massachusetts Institute of Technology, who has for many years made the examination of water supplies a study.

XIV was from Hinesburgh Pond.

XV " " mouth of suction pipe.

XVI " " breakwater, 26 feet.

XVII " " " 10 "

He reported analysis as follows :

EXAMINATION OF WATER FROM BURLINGTON, VT.

[Results expressed in Parts in 100,000.]

no.	Date Rec'd.	Unfiltered Water.		Solid Residue.		Total at 212° F.	Chlorine.
		Ammonia.	"Albuminoid Ammonia."	Inorganic.	"Organic and Volatile."		
XIV.	5 March '85	0.006	0.020	5.02	1.80	6.82	0.26
XV.		0.002	0.015	5.74	1.82	7.06	0.02
XVI.		trace.	0.008	5.52	1.52	7.04	0.18
XVII.		trace.	0.008	5.96	1.86	7.82	0.20

WM. RIPLEY NICHOLS.

BOSTON, MARCH 10, 1885.

Charles J. Alger, Esq., Chairman Water Committee, Burlington, Vt.

DEAR SIR:—The samples of water received from you on the 5th inst. have been duly examined, and you will please find enclosed the results of such examinations as can be expressed in figures.

The waters are very similar; they are all practically colorless and free from suspended matter. The residues left on evaporating the water are tinged with yellow, and when heated over the lamp blacken, showing the presence of carbonaceous (vegetable) matter, which all such surface waters contain. They are practically free from nitrogen, as nitrates or nitrites.

As far as the chemical examination alone shows, I can see no reason why either one should not be fully suited for all purposes of a town supply.

As to the second point on which information is desired—whether chemical examination shows any reason to prefer one to another—I will say that Nos. XVI and XVII are as nearly alike as two bottles of water would be if dipped successively from the same point; between these two and the other two the differences are slight, but in some respects real. I lay no stress upon such a difference as between 0.26 and 0.18 chlorine where the whole amount is so small, unless the determinations have been made with a view to minute accuracy, in which case it would be necessary to operate upon larger quantities of water than I had at my disposal. The remarkably small amount of chlorine in XV is, however, noticeable and probably means something. I should, however, base no choice upon chlorine or upon the “solid residue.” In fact, the “albuminoid ammonia,” which is an index of certain sorts of nitrogenous organic matter is the only determination which gives us differences worth considering, and, taking this into consideration, I should arrange the waters in the following order of preference:—

- (1) XVI, XVII., best.
- (2) XV.
- (3) XIV, least desirable.

At the same time, it is quite possible that questions of economy or prospective contamination might lead me—if I knew all the facts in the case—to give the preference to XV or XIV, as I see no real objection to the use of either one.

Yours respectfully,

WM. RIPLEY NICHOLS.

MARCH 16, 1885.

C. J. Alger, Esq.:

DEAR SIR:—Your favor of the 13th inst. is at hand. I am more than ever amazed at the small amount of chlorine in No. XV, if, as you say, it came from the lake and near the shore.

There are no streams or lakes or ponds about here where the chlorine runs so low, although in the western part of Massachusetts I have found less than .01 part in 100,000. As, however, the lake water at the breakwater contains about .2, it is incomprehensible to me how the chlorine should be so much lower nearer shore. I have verified my results so that there is no possibility of mistake in the *fact* although I do not pretend that the figures given (0.02) represent with absolute accuracy the small amount. Before pronouncing between XVI,

XVII, and XV, I should like to have another sample from the pumping station.

If you had said XV was from pond and XIV from pumping station, it would be more in accordance with the figures, for I can conceive that a pond in your region might have less chlorine than the lake. Is it a possible thing that the person taking the samples *could* have misplaced, or rather interchanged, these two? Or is it within the range of possibility that the bottle had been used in a druggist's shop before used by you? I merely ask these things because I am much puzzled. If you let me have another sample of the pumping station water, it will be easily seen whether any mistake can have occurred.

Yours respectfully,

WM. RIPLEY NICHOLS.

He was informed bottles had never been used and no mistake could have been made.

We then informed him whence these samples were taken, after which he wrote the following letter, and after examining another sample from the same source, reported it as substantially the same as before. We then sent him a copy of the pamphlet containing Judson's report to Senator Edmunds; copy of Health Officer's report; map of the City, and the Government map of the Bay, etc., giving him such information as we could, in a letter, of the surroundings. We got then his final report as follows:—

BOSTON, MARCH 19, 1885.

Chas. J. Alger, Esq., Chairman of Water Committee, Burlington, Vt.

DEAR SIR :—Since my previous report you have put me in possession of details as to the localities from which the various samples of water were taken, and as to the Burlington water supply, and have asked my opinion on various points.

In reply to your questions, I would say that in my opinion the *chemical examination* shows no evidence that the water at the pumping station is otherwise than well suited for use, nor does it show sufficient differences between the water at the pumping station and at the break-water to justify any considerable expense in extending the suction main into the lake. I must say, however, that *on other grounds* it seems to me that the expense would be justified, partly to overcome the prejudice which naturally exists against water taken so near to the wharf line, and partly because I think there is real danger of occasional accidental contamination. If however, I felt sure that the single sample of water which I have examined, really represented the average chemical character of the water for the whole year, I should think that any risk attending the use of the water was so slight, that it might practically be neglected, and that the water might be used for the present and for some years.

As you suggest, a check could be kept upon the possible increase of impurity, by periodical analysis, but it seems to me that a more satisfactory method would be to choose that season of the year at which navigation is most active, and to consider what conditions of wind, and other circumstances, would be most favorable to the pollution of the supply, then watching the opportunity, aim to get the *very worst samples* which could possibly be obtained. If these, in sufficient number, were of a degree of purity approaching that of the sample which I have examined, I should consider the water safe to use. I know nothing of the danger of contamination at the breakwater, but should suppose it to be very slight.

With reference to the pond, I see no objection to the water at present, but I fear that in summer it would be more liable than the lake to the growth of those vegetable organisms of low order, which give so much trouble in many of our water supplies.

With reference to the water of other cities and towns, I should consider that the water supplied to Burlington, judging from the sample sent me, compared favorably with the average, and it is better than many.

With reference to typhoid fever, I do not see that any evidence is adduced to show a connection between the water and this disease. I certainly find nothing in the Health Officer's report which would lead to that conclusion, and I do not believe that water as good as the sample which I examined could with any reason be accused of producing or disposing towards typhoid fever.

I believe I have answered your questions according to my ability. If I can be of further service, please inform me.

Your's respectfully,

WM. RIPLEY NICHOLS.

Mass. Institute of Technology.

At the same time that we sent to Professor Nichols the last samples, we sent samples to Professor Seeley at Middlebury College—samples from mouth of suction pipe at the pumping station—one from Rock Point, one from Hinesburgh Pond, and one from a point 3,000 feet west of pumping station, marked respectively XXII, XXIII, XXIV and XXV. To these he appended four other analyses for comparison, and reported as follows :

C. J. Alger, Chairman of Board of Water Commissioners, Burlington, Vermont.

DEAR SIR :—I herewith forward the results of my examination of samples of water marked XXII, XXIII, XXIV, XXV, received from you.

In my analysis I have taken into account the entire solids in a gallon determining what part of these are composed of mineral matter, and what part organic and volatile. It has not seemed necessary to determine the amount of each constituent in the mineral material, nor the exact character of the organic matter.

The mineral matter dissolved in the water is in each case mostly lime in the form of bi-carbonate ; a trifling amount of magnesia ; also as bi-carbonate. The amount of chlorine as common salt is simply a trace, of sulphuric acid as lime sulphate hardly a trace.

The small amount of solid material in each sample is very noticeable. A peculiarity of one sample, namely, XXIV, was the presence of a swarm of minute crustaceans of the genus *byclops*.

I have tabulated my results and as a means of comparison have introduced results of the examination of other waters :

The numbers from XXII to XXV indicates Burlington waters : XXX is a water from the Hudson River above Lansingburgh, taken Nov. 12, 1884 : XXXI water from same river taken at Albany outside pier opposite Quackenbush street, March 14, 1872 ; XXXII a sample of Croton water. These three were analyzed by Prof. C. F. Chandler of New York.

The sample XXXIII was taken March 20, 1885 from a well on my own premises.

The results are expressed in grains in the United States gallon of 231 cubic inches.

	Burlington.	Burlington.	Burlington.	Burlington.	Hudson River.	Hudson River.	Croton.	Well.
	XXII.	XXIII.	XXIV.	XXV.	XXX.	XXXI.	XXXII.	XXXIII.
Mineral matter in U. S. gallon, grains.	2.356	2.570	1.898	3.008	3.382	7.614	6.233	28.505
Organic and Volatile matter, grains.....	1.110	0.993	1.189	0.993	1.283	0.699	0.670	7.010
Total solids in U. S. gallon, grains..	3.476	3.563	3.087	4.001	4.665	8.313	6.873	35.515

This tabulated statement exhibits the character of the Burlington waters, showing them to be remarkably pure, the greatest amount in any single sample being barely more than 4 grains to the gallon. They contain less solid matter than the purest Hudson River water, and only about half as much as the Croton, though the amount of organic matter is a trifle more. Compared with the well water which in this case is very hard, these samples show only about one ninth as much solid matter.

Very truly,

HENRY M. SEELY,

Middlebury, Vt., March 26, 1885.

The Burlington waters and the well above changed to a table of grains in 100,000 parts would be as follows :

	Burlington.	Burlington.	Burlington.	Burlington.	Well water.
	XXII.	XXIII.	XXIV.	XXV.	XXXIII.
Mineral Matter.	4.057	4.407	3.255	5.158	48.870
Organic and Volatile Matter.	1.903	1.703	1.953	1.703	12.020
Total solids	5.960	6.110	5.208	6.861	60.898

We then gave him locations from which samples were taken, Health Officer's report, expert Judson's pamphlet, etc. He then gave us letter of March 31st, answering the five questions we asked him :

MIDDLEBURY, Vt., March 31, 1885.

C. J. Alger, Esq.,

DEAR SIR :—Perhaps the following statements will help you in your study of the analyzed waters.

As to modes of calculating results there are two ; one in which the results are expressed in grains in the United States gallon, a second, the prevailing English method, in which the amounts obtained are indicated in parts of one hundred thousand, or when nitrates, ammonia, albuminoids, etc., are accounted for, this is sometimes done by parts in one thousand million.

To compare the analysis expressed in grains of the U. S. gallon with the results when expressed by parts of one hundred thousand, one obtains the result accurately by dividing the number of grains found, by the number of grains of water in the U. S. gallon, to wit, 58.818, and multiplying the quotient by 100,000. One may approximate the result by multiplying the number of grains by 2.

Let me answer your questions so far as they admit direct answers.

1. Are any or all these samples, and which, fit for domestic use ? I find nothing to forbid the use of a single one, and answer, all may be used.

2. Are there any indications or suspicions in any of them of sewage contamination ?

There are no definite indications. In XXIII and XXV there is a small amount of flocculent matter, that I should prefer were absent,

and this matter in the proportions present, only casts the shadow of a shadow of suspicion on these samples.

3. How would you rank the waters in fitness for town supply?

A hard question. But for myself I should rank them in this order, XXII, XXIV, XXIII, XXV.

4. Do you find any disease producing element in them? No.

5. Is there enough essential difference in the several samples to warrant any considerable expenditure to change from one to the other if one is our present supply? With the understanding that the present supply is uniformly of the character of these samples, and not liable to future contamination I answer: No.

I shall be glad to give any help within my power.

Yours very truly,

HENRY M. SEELY.

After this (in May.) the Chairman went to Middlebury and spent the day with Prof. Seely, exhibiting to him all the papers and figures in the case from all the chemists, examined with him certain New York State Health Board analyses, Dr. Chandler's late analyses and report on Albany water supply, and Prof. W. O. Atwater's report on Middletown supply. Prof. Seely at our request examined other matters, and then reviewed the whole in a letter of June 2, 1885:

MIDDLEBURY, VT., June 2, 1885.

C. J. Alger, Esq.,

DEAR SIR:—I need not add many words. The letters of Prof. Nichols so admirably cover the ground, and so completely express my own thought, that to say anything would be merely a repetition.

I will however say that the Water Commissioners owe it to themselves and to those who may wish to find fault, to continue the work they have commenced—that of having the water steadily analyzed, and to ascertain the facts in regard to the flow of the current along past the pumping station.

You need the *facts* in the case, opinions you can have for the asking, but the value of these opinions is pretty clearly shown on many of the pages of the Judson pamphlet on the water supply. It seems essential that you should establish the facts in regard to the direction of the current past the pumping station. The direction of this flow seems pretty well made out during calm weather. How it is affected by a strong wind from the south, from the north, from the west, is not so clear. In my opinion, the observations should be made as near as possible to the crib where the water is taken. You should not be satisfied, as it seems to me with a single observation, nothing short of many taken under various conditions should satisfy you.

The great trouble with the people who accept the statements contained in the "Water Supply" is, they are satisfied with opinions, and draw their conclusions from these opinions.

Engineer Judson's observations are valuable as far as they go, but you will not be satisfied with a single test made one day during a calm, and one more made during a blow. Opinions may be based on such

insufficient data, but they will prove unsatisfactory. Your knowledge in regard to the character of the water outside the breakwater obtained from chemical tests, is worth ten thousand times the amount of an opinion which vaguely guesses, "the water (from the open lake) which would thus be reached, would be but little better than that at the outer face of the breakwater."

Facts in regard to the uniform purity of the water at the pumping station, and the direction of the current there under all conditions of wind and weather are what you must have.

Your's most truly,

HENRY M. SEELY.

As to the well referred to in his analysis, the following letter will give some additional facts. It should be read also in connection with the analysis referred to in the Health Officer's statement as to some recent analysis of water from pumping station, as given on first pages of this report :

MIDDLEBURY, VT., March 28, 1885.

C. J. ALGER, ESQ.,

DEAR SIR:—

Your card is received and in reply let me say that the water from the well referred to in report is such as is in daily use by my own family. This water has been in excellent repute these years, neighbors often resorting to it on account of its desirable character. This is the well from which we have been drinking fifteen years and I may add that our family have been remarkably well.

Yours very truly,

HENRY M. SEELY.

Prof. Seely made some of the original analyses of the City water supply, but we have been unable to find any record of them on file or in any City reports,—and he had no copy of previous analyses.

It will be noticed that these analyses are not all made in the same style, and details are not figured out on the same plan—both are approved methods. The method where amount of free and albuminoid ammonia are developed is of late years more generally in use. To understand this the following general observations are copied from another report.

The terms "free ammonia" and "albuminoid ammonia" demand special comment. Animal and vegetable matter in the process of decay undergo various transformations. While the intermediate products of this decomposition are numerous and complex, more or less of them ultimately reach the form of ammonia, the odor of which

is often very apparent near decaying organic matter. In certain stages of their decomposition these matters assume forms in which they may be changed very quickly to ammonia by the action of certain reagents used in the chemical laboratory. The matters in this stage of decay are often classed together as "albuminoid ammonia." It is ordinarily believed that this partly decomposed organic matter may, when existing in sufficient quantity, be injurious to health, either by directly inducing disease or by affording support to disease germs. That is to say a water which in its natural condition is so nearly pure as to be perfectly healthful, may become contaminated by decaying organic matter, and may then be harmful, either in itself or by affording support to minute organisms which multiply rapidly in its presence, and when taken into the body cause disease.

Very little is definitely known as to either the precise nature of these products of decay or the ways in which they may themselves be injurious, or the conditions under which they may harbor the germs of disease. But the results of a considerable amount of accumulated observation have led scientific observers to look with suspicion upon waters which contain any considerable quantity of the decaying matters which are classified together as albuminoid ammonia. In brief, the free ammonia is that which has been produced in decay of organic matter, while the term albuminoid ammonia is applied to matters still undergoing decomposition. Free ammonia is, then, an indication of past, and albuminoid of present, contamination.

Some authorities lay great stress upon the determination of the amounts of free and albuminoid ammonia as indications of the wholesomeness or unwholesomeness of waters. Others insist upon determinations of the dissolved oxygen, organic carbon, organic nitrogen, nitrates, nitrites, and, under certain circumstances, of chlorine, etc., while others prefer to depend largely upon experimental tests of the physiological action of the water upon animals. If the analyses are to be limited to a small number of tests, those of free and albuminoid ammonia are, perhaps, as valuable as any.

The other method is by giving amount solid residue of mineral matter, and organic and volatile matter. Of the amount of this that may be tolerated, see item further along referring to wells. As to quantity of free and albuminoid ammonia that may be allowed, and varying opinion of chemists, more will appear when waters used by different Cities are compared.

Thus much for the chemists and their opinions. Their figures do not exactly agree. It would not of course be expected that in the examination, two quantities of water taken from the same bottle of water, that the decimal fraction would be exactly the same in each case. The figures they have given us do not very much diminish our faith in

science. We are inclined, however, to give more faith to their opinions, given before they know from whence the samples are taken, than to their musings afterwards; for we do not think they are any better able, if as well able, to determine many questions after a few details given by us to them, as to future contamination for instance, after examining a map, Health Officer's report, and such like documents, as we or you are, after living here for thirty years. Can a man who has never been in Burlington, tell as well as we, the probable future of contamination at Mark's Bay? Do we not know better than he the prospective growth of Burlington, and that growth on the shore must largely be at the south, and that when as much more is done on the south as has been done the last twenty years, larger quantities of sewage must be discharged into the bay south of the draw-bridge, and in the vicinity of the Howard Park—all nearer Mark's Bay than the present pumping station. Do we not know that the inlet to this bay brings the filth of Shelburn, Shelburn Falls, and the low stagnant swamps, with much from Hinesburgh, and the sewage from Hinesburgh Village, and that also of the larger manufacturing village, just east of that, with its factory, mills, shops, etc., and that there is, or recently has been, a tannery on the next branch south of Hinesburgh Village.

Our course in carrying on this investigation has been largely what Prof. Seely recommends in the last of his letters. We have aimed to get facts and to report them. We found no facts on record in respect to any or all analyses heretofore had, except a single line of figures from one of Prof Collier's analyses some years ago. We got the worst samples we could get, at first, to know how terrible our case was. Let us see what that worst was, let us compare it with others and see how we stand. Taking the *average* of all the samples at the pumping station, we find the albuminoid and the total solids and organic and volatile matters, to be as given in the fol-

lowing table. The figures with which they are compared are taken from late reports.

Albuminoid Ammonia in 100,000 parts.		Total Solids in 100,000 parts.	
1. New Haven, Conn .....	.0080	1. Plymouth.....	2.6
2. Ayer .....	.0080	2. Ayer	3.3
3. Brooklyn, N. Y.....	.0083	3. New London	3.9
4. New London .....	.0080	4. Providence	4.1
5. Taunton, Mass .....	.0100	5. Worcester	4.4
6. Plymouth.....	.0100	6. Springfield.....	4.9
7. Burlington, Vt .....	.0135	7. Taunton	5.8
8. Worcester .....	.0140	8. Brooklyn.....	6.
9. Philadelphia.....	.0150	9. Burlington	6.30
10. Baltimore .....	.0200	10. New Haven.....	7.8
11. Rochester .....	.0230	11. Boston	8.5
12. Cincinnati.....	.0240	12. Baltimore	9.4
13. Oswego .....	.0250	13. Jersey City	10.
14. Washington.....	.0270	14. Washington	11.5
15. New York .....	.0270	15. Detroit	11.8
16. Hoboken .....	.0300	16. Philadelphia.....	14.3
17. Jersey City .....	.0400	17. Hoboken	15.6
18. Springfield, Mass.....	.0530	18. Cincinnati.....	16.3
19. Detroit .....	.0800	19. New York	18.
20. Boston .....	.0800	20. Oswego.....	18.

In albuminoid ammonia which we are told is the most suspicious element of all, the purity of our water ranks seventh in this list of Cities, while in respect to total solids we rank ninth.

As to the figures first given by Prof. Witthaus, as the dangerous or suspicious limit, and which Prof. Nichols seems inclined to confirm, it is to be noted that chemists do not agree in respect to them. Here, as in respect to the origin of typhoid fever, we seem to have an English and an American theory, and these two chemists incline to the English, or rather they would recommend a purity satisfactory to the English theory. Some discussion on this subject that seems to us of value in a late report before referred to of Prof. Atwater, of the Wesleyan University, we copy here as follows :

Prof. Wauklyn, of London, one of the leading students of such subjects, and the author of the method of estimating the character of the water by the "free" and "albuminoid" ammonia, says essentially as follows :

"If water yields no 'albuminoid' ammonia it may be passed as organically pure. A water giving less than 0.005 part of albuminoid ammonia in 100,000 parts may be regarded as very pure. A water containing 0.005 part of albuminoid ammonia, together with a consid-

erable quantity of free ammonia in 100,000, is suspicious, but in the absence of free ammonia the albuminoid ammonia may be allowed to amount to something like 0.010 part; above 0.010 part should be regarded as very suspicious, and, according to Wauklyn, 0.015 part should condemn the water."

On the other hand Dr. Smart, who has made the subject a study in this country, says:

"The waters of the purest mountain streams in our unsettled West, where animal contamination is impossible, contain 0.014 part per 100,000 of albuminoid ammonia. At other times they may yield 0.020 or 0.025, or more, and yet be regarded as comparatively innocent."

Dr. Smart found the Little Wind River, Wyoming, a stream running over a rocky bed, and containing only about 8.75 parts of total solids in 100,000, to give 0.084 part of albuminoid ammonia, and the North Platte River from 0.080 to 0.050 parts.

To recapitulate, then, as Prof. Atwater says, it seems that from 0.010 to 0.015 part of so-called albuminoid ammonia in 100,000 of water, is regarded by some authorities as suspicious or dangerous; that one special student of the subject, Dr. Smart, reports that he has observed fever, of a kind which he names aquamalarial, coming when the albuminoid ammonia in the drinking water reached 0.016 part, and increasing as the albuminoid ammonia increased. On the other hand, many natural waters, ordinarily supposed to be perfectly healthful, have much more than this, and the albuminoid ammonia in the water supply of some cities, whether the supply be healthful or not, goes far beyond this danger line of 0.015 part in 100,000. For myself, I am, with, I believe, the majority of chemists, of the opinion that it is impossible to prescribe the point at which a water becomes dangerous to health, so much depends upon a variety of conditions of which the larger portion are very little understood.

The water supply at Middletown, Conn., was much like ours in total solid residue, but in the element of albuminoid ammonia it averaged 0.043; and Prof. Atwater says of that water that had more than three times the quantity of albuminoid ammonia that our present supply averages:

"While the bearing of the results of the chemical analysis is a matter which the chemists cannot settle, I may be permitted to say that what I have found in the water has not prevented my using it as before. Nevertheless, it is most earnestly to be desired that our city water may be freed from the vegetable matters that have at times by their decay actually polluted it, and may, for all that any one can positively affirm, be injuring the health of a larger or smaller number of those who use it."

So much in this line from chemists and chemistry. When we read their fine theories we may well wonder with all the impurities in air, water and food, that there are any living healthy beings left alive on the earth. We would not however discredit their facts in the least, nor their average figures,

The purest water in the world is none too good for use here if we can get it at any reasonable expenditure, but we do not think we shou'd desire to be satisfied simply with the *expenditure* unless we make improvement thereby in the character of the water.

Your committee are aware and have been from the first, that if we had recommended going to the breakwater, and had so reported months ago, we should have been applauded for our wisdom, and our plan in respect thereto would have been adopted, and the necessary expenditure would have been made ere this.

We did not however reach that conclusion. We have not reached as yet any conclusion that we feel satisfied to recommend any large expenditure in carrying out.

We recommend principally to keep cool and wait and investigate yet awhile longer, and get more solid facts, and get rid of some of our popular theories if they have not facts under them.

We recommend no expenditure of money simply on Indian theories of analysis of water. The Indian looks at water and if it pleases the eye he gets nearer so as to smell the water, and if it be not offensive to the nose he then takes it in the mouth. If it does not offend the palate he swallows some of it. If the stomach does not reject it he swallows more, and if death does not speedily follow he calls it a good supply. Let us not on such theories jump to any large expenditures. We would not reject the evidence of the senses by any means, but we would strive to make science and sense agree, as theologians do to make science and revelation agree, and when they do not agree we may well believe some important fact has been overlooked or misapplied.

As we went on with our investigations of the lake waters, principally of those at the pumping station and at the breakwater, which had been the two sources or places most discussed by the people, we incidentally considered several other locations. Mark's bay, rock point, and had a sample taken from a point as far beyond the breakwater as that is beyond our present pumping station. All these places having had more or less public attention directed to them. We also carefully considered proposed outside sources of supply. We considered Colchester pond, and soon became satisfied it would not answer our purpose. The supply was too small in quantity for a growing City, and as it was not fed by any considerable stream, we would have to rely upon springs which apparently feed it, and besides that the water would have to be pumped, an element of expense which should be shunned if possible. We considered Hinesburgh pond, we visited it, found it a beautiful body of water, surrounded for the most part by a gravelly and rocky shore. Though it has no considerable inlet the quantity of water it daily discharges shows that there would be an abundance for our supply. The best thing about it too was that it could be brought here without any expense for pumps, coal bills, etc. We found that the outlet of the pond was 350 feet higher than our reservoir, and that we could take the water thither without rising at any point above the height of a straight line drawn from the outlet to the reservoir. The analysis of a single sample was not at all unsatisfactory. The expense of trenching and backfilling thirteen miles would be considerable, but that would be offset to a large extent by the benefit to our people from such a job of work, lasting for a year or more. The land damages too would be considerable, for we could not follow highways any considerable

portion of the way. The damages for diversion of the water from its natural course would also be considerable. We did not however proceed far enough with this to order a survey and estimate of expenses. We looked upon it however as in many respects a feasible plan. The annual expense would not be likely to exceed that of our present system, though it might cost from \$150,000 to \$200,000 at first; the element of interest would be largely offset by decrease of coal bills, engineers and firemen's services, and pump repairs, and rental of pump house grounds. The most important thing in favor of this pond as a supply is still to be named. We would be free from danger from fire. The location of our pump works in a lumber yard where such quantities of lumber are piled is very dangerous, and when a great fire comes, as sooner or later it always comes to such yards, we would be left without any pumping machinery, and without even a three days supply of water. Though we have certain brick fire walls surrounding our pumping machinery, that were designed originally to be fire proof, they could not stand such a fire as we shall have when these yards and the great storage sheds near our premises are burned. One of the first things we did when the present water board took charge of the water department, was to go to St. Albans and meet the managers of these railroad grounds and attempt to negotiate for larger grounds, so that we might have at least 100 feet open space left around our pump house. We were not able to get any terms for such space at present and but little encouragement for the future, owing to the condition of title and leases of the grounds.

If our supply came by gravity, as it would from that pond, we would be rid of all these dangers and have a supply ample for our purposes till we become more populous

than we are ever liable to become. The single analysis however would be no sufficient proof to warrant such an outlay, a dozen more would be necessary. If all these proved equally good it would then be time for detailed estimates.

We also considered the matter of Drive Wells that are so satisfactory in some other places, but could not come to the conclusion that they would be likely to be a success here. They would have to be located, as it seemed to us, near the Baxter place in South Burlington, on low land, and where considerable quantity of land could be had. And the water would have to be pumped to the reservoir. Besides this, the rock in all this region of low lands is largely a lime stone rock, and the quality of the water would be affected thereby. The supply, besides being affected by this, would be affected by surface filth and washings from the higher surroundings.

We also considered the matter of Artesian Wells, and had some correspondence in respect to cost of trying the experiment of seeking a supply in this way, and found, as we did in respect to drive wells, that an expenditure of \$1,000 would be likely to determine the success of this plan or of that, and in case of its success the amount thus paid out would go to the credit of the final cost at last. We are still favorably impressed with the artesian well plan, and should be glad to see such an experiment made. The well would be located somewhere near the reservoir grounds probably, and if it was put down 1000 feet, more or less, the dip of our rock here being to the east, we would reach a layer that followed easterly to the village of Williston or Richmond, would be down from half to three quarters of a mile deep, and if any check or crevice in the rock should chance to connect the well with a body or supply of water thus deep

in the earth, we would be well supplied. The pressure of the mountains around us would undoubtedly be sufficient to take the water to our reservoir. From what we can learn of this system we would suppose our chances of success in this way would be equal to one in ten. This matter was incidentally alluded to in a letter to Prof. Nichols, and he wrote us a note, advising that it was unsafe to go into this, unless we first obtained a geological survey of the locality that indicated favorably for such a scheme. On applying to Prof. Perkins, of our University, we found this survey was no small matter, not easily or hurriedly made, and not possible at present. We suggest that this matter be further considered.

In thus stating the many points that have been partially considered, and leaving them for public discussion and suggestion, we are aware that to many they may seem trivial and useless.

In respect to this work of extending the pumping main to the breakwater, and the expense of it, we had some consultation with a contractor doing somewhat similar work, and were advised to take the estimate the Mayor had given in his inaugural as the cost of this work, if we could get it done for that price, without further question. He believed that the ultimate total cost would be two or three times that sum.

We ought not to fail to give another item in respect to the breakwater position. Parties who have worked upon its extension and had occasion to be upon it largely, have repeatedly informed us that when they wanted water to drink there, they always obtained it by throwing their pails off on the east side and never upon the west side, as that on the east side was palatable and the other was not.

Every community has its water question. We have always had ours, and probably always shall have it. It was first springs or wells, and on them we relied for a supply in

our first public water system. It was then the river or the lake, and the lake prevailed. It is now the shore or break-water station.

RECOMMENDATIONS.

We recommend no hasty action, no large expenditures without thoroughly tested experiments at all seasons of the year, fully warranting the belief that we would be better off after we had made the expenditure than we are now.

Facts stated herein, as well as the fact contained in the extract given below from our Health Officer's report, would seem to satisfy all that our water supply is fairly good and safe.

"The fact that no case of typhoid fever was reported to the Health Officer during the year refutes the possibility of the cause of the appearance of this disease in 1884 being in our water supply as was at that time suggested."

We recommend keeping cool and gathering facts. Facts are valuable, while hasty opinions are nearly valueless. You can get opinions for the asking. In the monster petition, we have a series of "we believe" items, nearly twice as long as the Apostles Creed, but considerably less valuable. Gather facts and grow a good sized Grand List, and when the general public coolly decides the water supply is bad, or decidedly unsafe, and settles down upon another and better supply, we can get it safely and not till then. Incidentally while thus waiting and considering, we advise separating the pump pier from the wharf, by at least a five foot open space from the planking over it, down to three or five feet below low water mark, so that any surface filth that may chance to float along the wharf may pass here without beating out around the pier over the mouth of the suction pipe.

We have also considered the question of a cement bot-tomed reservoir that has been more or less talked of in public

of late. While we find but few such have been built in this country, and while the question of their durability in our climate is not settled, we nevertheless venture to recommend that one be built adjoining our present reservoir, and properly cemented, and so arranged that it may be used separately or in connection with the old one, and so that either or both may be readily and thoroughly cleaned out.

The talk about cleaning out our reservoir, stirring up the clay bedding in it, etc., and letting the sun shine in upon it for a day or two, has never struck your committee as a wise thing to do. Our City Engineer and others, questioned the wisdom of so doing. We consulted with Mr. D. C. Linsley, the original builder of our water works, in respect to this matter, and as to the clay bedding in it, and found the clay was there as a necessary part of the work, and that he did not doubt its value, and apparently that he doubted the value of a cement bottom, and that he recommended very "infrequent cleanings" of the reservoir. The past year the reservoir was not disturbed at all, and was not cleaned out, except by putting a man and a boat upon it for a couple of days to reach down with clamps and draw out vegetable matters growing there.

This matter of reservoir building with cement we do not consider as very pressing, but on the whole as desirable and wise as an experiment to be entered upon whenever funds are readily available. We advise a continued examination by competent chemists of the water at the pumping station, taken at mouth of suction pipe, the water in its natural condition, (i. e., without stirring up the sediment artificially as was done when the twelve grains of organic matter were obtained from a gallon), with full statement of strength of wind and length of time it has blown, its direction, under-

current, etc. The chemist should be unprejudiced, or else two samples should be taken from sources of which he should not be informed till after he had given his report thereon.

If Engineer Judson's observations of undercurrents in south wind prove correct we recommend a stoppage of the pumps after such currents begin to run till a change of wind occurs.

We urge the completion of Battery street sewer, so that the wash from that street, including waste from the gas house, shall not be carried direct from the street to the lake as is now done, but be taken to the place where the other foul matter is discharged in the vicinity of the draw bridge.

As air is the great purifier of decaying organic matter we suggest that more attention be given than we were able to give to the patent process of pumping air into our pumping main while we pump water.

We suggest too a consideration of the plan of building a large reservoir cistern near the lake, into which the sewer should discharge its contents, and from which it could be pumped off southerly in summer for irrigation purposes, as is done in some communities.

We have perhaps sufficiently answered the matters referred to in the monster petition, and yet the report that anonymously appeared, and was largely distributed among our people, should have some attention. The report contained in it from the U. S. Engineer, to Senator Edmunds, deserves some attention. His experiments to determine the under currents past the pumping station were scientifically made, and confirm our original statement as to the current caused, even in a calm, by the general course of the water in the lake, though further than this they do not confirm our

statement, but flatly contradict it. We had over sixty tests made there in a crude way and reported, some in summer and some in winter, and some in spring, that proved as far as they proved anything, that the currents were the opposite of the current of wind. When a change of wind first occurred the undercurrent would not be appreciable, but after it had blown with some force for a time, the current would be manifest. The current to the south in south wind, was sooner appreciable than that to the north and north-west in a north wind, which we judged to be due to the fact, that the bay to the north being small, was sooner filled than the large four mile bay to the south was, and that the undercurrent resulted largely from the power of the water seeking a natural level. Our tests reported to us, practically confirmed the statements quoted in our preliminary report. We hope these will be repeated with more approved appliances than those we used. Mr. Judson gives the distance to the breakwater as 1000 feet, while we had given it as 1500 feet. We had the distance measured on the ice, and from the pumping pier to the breakwater it was 1450 feet. Mr. Judson gives opinion only as to quality of water, and if his undercurrent movements are not correct, and ours are, and his distances certainly are not correct, the dangers he apprehended from undercurrents, as he gave them, largely disappear.

Again, it was found that the same vegetable growth that troubles us in the reservoir also infests certain portions of the bay. This vegetable growth seems not easily controlled, and it is largely with respect to this that we advised the cement reservoir. This may be, and in reports is generally stated to be, the cause of the fishy taste of water. In some of the reports too it is said to act mechanically like unripe fruit, and to be the cause of diarrhoeal complaints, but not to be generally regarded as organically injurious.

We have too incidentally considered the use of well waters in a place as populous as this, and the uncertainty of the test of the palate as to safety of such waters. The analysis of well water given by Prof. Seeley was alarming to us who had considered the statement as to quantity of total solids in a gallon given in the statement of the Health Officer at the beginning of this report as the limit allowable. We consulted in respect to this incidentally with Prof. Sabin, and he gave us the facts in reference to certain wells in the City whose waters had just been analyzed at the College laboratory as follows: A well on Colchester avenue gave 19 grains to the gallon, another gave 22, and still another from the height of land near the College grounds, but not on them, was found to show 133 grains per gallon. We consulted with the owner of this well as to its use, and found that it was not very generally in use, as he was a taker of City water. Among other things he told us, a professional gentleman of this City, now deceased, had been accustomed as he passed, to call there for a drink from that cool pure well, and to tell how he had longed for a drink of water from it when he had traveled abroad in warmer climates. He died of blood poison, not supposed however to have been caused by drinking water from this well.

With as much filth on the surface as there is in this City, and with possible leaks in our sewers, discharging filth into currents of water in the soil through which they pass, we should deem it unsafe to use water from any well in the City.

We think one fact should be preserved here for comparison, and so we give the figures before stated to have been found by us, of an analysis by Prof. Collier, of water from the "pumping pier" and the "breakwater" in the summer of 1872. The memoranda we found, did not give any more

definite description than we have given of the exact location from which the samples were taken, their depth, or the state of the winds. We have changed the figures to make them correspond to the parts in 100,000 grains, that they may be the more readily compared with similar statements by the other chemists.

ANALYSIS BY PROF. COLLIER IN 1872.

No. 13 was from "Breakwater."

No. 14 " " " " Pump Pier."

SOLID RESIDUES IN 100,000 PARTS.

Total Mineral (No. 13) 5.468, (No. 14) 5.395.

" Organic " 3.780, " 4.580.

" Impurities " 9.248, " 9.975.

It will be noticed that the total impurities at those points were greater then than the most our analyses show them to be now. The transfer of the sewer discharge to a more southern position as before stated, has had a tendency to improve rather than to make worse the quality of our water supply as opinions before quoted have intimated was likely to be the result in a few years.

If any have read our report thus far, we thank them for their attention and patience, and make this apology for its length and general character, by saying that when we were appointed to do this work, we did not know our own ignorance, as we do now, upon these topics, and our unfitness for the work assigned to us, or we should not have undertaken it. The delay in reporting since July, was not our fault, for we were practically ready then, but were advised by superior officials not to report at that time when many strangers were in town, and might be unfavorably prejudiced by a discussion of this question at that time.

Before closing this report, the Chairman, on whom has principally rested the responsibility of the investigations herein and the making of this report, wishes to tender his acknowledgments to the other two members of the committee for the cheerful manner in which they have seconded his efforts, and for joining with him in presenting the same as the report of the full committee. He desires also to make due acknowledgment to Mr. F. H. Parker, Superintendent of the Water Department, for various important aids, as well as to City Engineer Barbour, who, with the full committee and Superintendent, went to Hinesburgh Pond and made observations and took levels, &c. Thanks are due to Engineer Thomas at the pumping station for various observations reported on currents, winds, &c.

All of which is respectfully submitted.

C. J. ALGER, Chairman.

J. W. GOODELL.

HIRAM WALKER.

February, 1886.

TWENTIETH
ANNUAL REPORT
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.
DECEMBER 31, 1886.

BURLINGTON:
FREE PRESS ASSOCIATION.
1887.

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TWENTIETH
ANNUAL REPORT

OF THE

With Compliments of

FRANK H. PARKER,

Please Exchange.

Superintendent.

CITY OF BURLINGTON, VT.,

December 31st, 1886.

BURLINGTON :
FREE PRESS ASSOCIATION.
1887.

CITY OF BURLINGTON, VT.
WATER DEPARTMENT.

1886.

WATER COMMITTEE.

Alderman PEIRCE, *Chairman.*

Alderman WEAVER,

Alderman MCKILLIP.

SUPERINTENDENT.

F. H. PARKER.

COLLECTOR.

G. D. WELLER, *City Treasurer.*

PUMPING STATION.

JOEL W. THOMAS, *Engineer.*

ALFRED J. HOWARD, *Fireman.*

FOREMAN.

WILLIAM CASSIDY.

REPORT

OF THE

Superintendent of Water Works.

To the City Council of the City of Burlington :

GENTLEMEN—The following is a statement of the receipts and disbursements of the Burlington City Water Works, from January 1 to December 31, 1886.

RECEIPTS.

From G. D. Weller, City Treasurer,.....\$16,151 31

DISBURSEMENTS—CONSTRUCTION.

Service pipe and fittings.....	\$ 626 27
Labor on services.....	570 77
Cast iron pipe, packing and lead.....	2,237 41
Labor laying mains.....	265 51
Gates.....	96 58
Gate and cut-off boxes.....	210 65
Sewer to reservoir lot.....	282 54
Hydrant	33 33
Incidentals.....	52 46
	- ————\$ 4,375 52

CURRENT.

Pay rolls.....	\$1,176	48
Material for management and repairs...	269	80
Office expenses	56	87
Printing, advertising and postage.....	50	27
Superintendent.....	1,000	00
Horse keeping, shoeing and repairs.....	250	95
Filling wash-outs	108	27
Gate and cut-off boxes.....	239	86
Hydrants	366	63
Setting hydrants.....	100	63
Repair of hydrants.....	50	75
Repair of tools.....	65	99
Incidentals.....	41	50
Replacing cement pipe {		
Pipe.....	1,213	96
Labor	1,109	67
Lead, packing and wood..	183	06
Gates.....	204	73
		<u>\$ 6,489 42</u>

PUMPING.

Pay rolls.....	\$1,839	45
Supplies.....	128	74
Fuel.....	1,980	28
Repairs to machinery.....	525	28
Repairs to buildings.....	58	81
Rent of ground.....	150	00
Repairs to motor	45	14
Incidentals.....	57	01
		<u>\$ 4,784 71</u>

METERS.

Meters.....	445	75
Repairs, setting and freight	55	91
		<u>\$ 501 66</u>

RECAPITULATION.

Construction	\$4,375 52
Current.....	6,489 42
Pumping	4,784 71
Meters.....	501 66
	<hr/> \$16,151 31

We hereby certify that we have examined the vouchers and accounts of the Superintendent of Water Works, from January 1 to December 31, 1886, and find the same correct.

MICAH H. STONE,
GEO. W. BECKWITH, } Auditors.
W. C. ISHAM,

WATER PUMPED.

1886	Gallons.
January.....	17,211,125
February.....	17,248,150
March.....	19,518,500
April.....	17,144,125
May.....	19,387,900
June.....	20,487,750
July.....	23,472,325
August.....	22,579,950
September.....	21,911,025
October.....	17,845,125
November.....	13,918,525
December.....	16,237,025
Total water pumped in 1886.....	<hr/> 226,961,525
Total water pumped in 1885.....	<hr/> 209,026,325
Increase in 1886.....	17,935,200
Average daily consumption in 1885.....	572,874 gals.
Average daily consumption in 1886.....	621,812 gals.

SERVICES.

There have been added 104 services of the following sizes:

2.....	4	inch pipe
4.....	2	“ “
2.....	1½	“ “
4.....	1	“ “
4.....	¾	“ “
88.....	½	“ “

Six services have been discontinued, four of which were replaced by four of the above services.

MAINS.

New mains, of four-inch cast iron pipe, have been laid in the following streets:

Clark street, southerly from Grant street.....	250 feet
Drew street, southerly from Strong street.....	335 “
Hayward street, extended northerly.....	24 “
North Willard street, extended southerly	72 “
Oak street, easterly from Walnut street.....	210 “
Walnut street, northerly from Archibald street.....	250 “
Walnut street, southerly from North Bend street...	620 “

Total length of new mains.....1761 feet

The cement pipe, in the following streets, has been replaced this season—

WITH FOUR-INCH CAST IRON PIPE.

Elm street, northerly from Spruce to Adams street 635 feet

WITH SIX-INCH CAST IRON PIPE.

Spruce street, easterly from St. Paul to Union street	930 “
St. Paul street, southerly from Spruce street.....	536 “

Williams street, between College and Pearl, replacing pipe broken by sewer 100 feet

The three-inch pipe purchased from the Aqueduct Company has been replaced in the following streets—

WITH TEN-INCH CAST IRON PIPE.

Pearl street, from Champlain to Church street.... 1,163 “

The connections with this pipe and pipes in the intersecting streets has been made with six-inch cast iron pipe.

Pine street..... 42 “

St. Paul street..... 42 “

Elmwood Avenue..... 24 “

And with four-inch cast iron pipe at George street 24 “

Total length of pipe replaced..... 3,496 feet

TOTAL LENGTH OF PIPE NOW IN USE.

Cement..... 98,714 feet

Iron..... 54,664 “

Total feet pipe..... 153,378

Total miles pipe..... 29.04

HYDRANTS.

The hydrants, set this season, are located as follows :

LOCATION.	KIND.
Elm and Spruce, northwest corner.....	Lang Post.
Elmwood avenue and North, northwest corner...	“ “
First, north side, near Winooski avenue.....	“ “
Grant and Winooski avenue, northwest corner...	“ “

Hayward and Howard, northwest corner.....	Lang	Post.
Murray and Allen, northeast corner.....	"	"
North Union at Grant, east side.....	"	"
North Union and Pearl, northeast corner.....	"	"
South Union, at junction with St. Paul.....	"	"
Winooski avenue, opposite Methodist Church....	"	"

With the exception of the hydrant from Hayward street pipe, the above were set to replace underground hydrants.

Total number public hydrants.....	143
Total number private hydrants.....	20

Total..... 163

GATES.

The following old gates have been removed :

Elmwood avenue at Pearl.....	1	4 inch
Pine at Pearl.....	1	4 "
St. Paul at Marble avenue.....	1	4 "

Total removed..... 3

The following gates have been set this season :

Elmwood avenue at north line Pearl.....	1	6 inch
George at north line Pearl.....	1	4 "
Pearl at east line Champlain.....	1	10 "
Pearl at west line Church.....	1	10 "
Pine at south line Pearl.....	1	6 "
St. Paul at south line Pearl	1	6 "
St. Paul, 536 feet, south of Spruce street pipe...	1	4 "
Walnut at north line Archibald.....	1	4 "
Walnut at south line North Bend.....	1	4 "

Total added..... 9

Total number gates now in use..... 257

PROPOSED IMPROVEMENTS.

By a vote of the Board of Aldermen, May 17th, 1886, the City Treasurer was authorized to borrow \$24,000 for four years, and place it to the credit of the water department for the purpose of building an additional reservoir, making needed improvements at the pumping station, and extending the suction pipe to the pumps farther in the lake. Plans and specifications were prepared, and bids received, for the construction of the reservoir, and estimates were obtained for the other improvements.

On further consideration, it was thought best to issue bonds and distribute the expense over a longer period. A city meeting was called to take action in reference to bonding, an offer was made to take the issue of bonds at a price that would make the interest $3\frac{3}{8}$ per cent per annum; but the resolution authorizing the work was dismissed, and the improvements have not been carried out.

CURRENT.

The repairs made during the year have been as follows :

On cement pipe.....	16 breaks
“ “	11 leaks
“ “	2 pick holes
On iron pipe.....	3 breaks
“ “	12 leaks.
On service pipes...	17 “
On broken hydrants.....	4 “

One hundred and thirty-four iron stop boxes, and 38 iron gate boxes have been set to replace wooden ones.

PUMPING.

The amount of water pumped is the largest since 1880, sixty per cent of the increase was during the four summer months.

Shavings were used for fuel 17 weeks. The low pressure steam cylinders to pump No. 1, have been re-bored and new piston heads put in, which has resulted in a material saving of fuel.

METERS.

There is now in use 262 meters, a gain of 23 over last year. Of this number 209 are owned by individuals and 42 are the property of the department.

The amount of water passed through the meters has been 30,628,260 gallons, the bills for which amount to \$7,670.69.

Of the water pumped, $13\frac{1}{2}$ per cent has been used through meters, yielding $26\frac{1}{2}$ per cent of the collections.

RECOMMENDATIONS.

Although the number of breaks has been less than the previous year, I would recommend that the appropriation for replacing cement pipe be increased, and renew the recommendation, so often made, that the pumping station and surroundings receive the needed repairs.

Respectfully submitted,

F. H. PARKER,
Superintendent.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.
 Burlington, Chittenden County, Vermont.
 Population by city census, 1885, 13,357.
 Works constructed, 1867-8.
 Owned by city.
 Source of supply, Lake Champlain.
 Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery. . . . H. R. Worthington.
2. Description

$\left\{ \begin{array}{l} a. \text{ Anthracite.} \\ c. \text{ Grate.} \\ d. \text{ Pittston.} \\ e. \$3.85.} \right\}$	$\left\{ \begin{array}{l} 35 \text{ weeks.} \\ 30 \text{ per week, 17 weeks.} \end{array} \right\}$
--	---
- of fuel. $\left\{ \begin{array}{l} g. \text{ Mill shavings, } \$30 \text{ per week, 17 weeks.} \end{array} \right\}$
6. Total pumpage for year, 226,961,525 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.

Cost of pumping figured on pumping station expenses,
 \$4,784.71.

11. Per million gallons raised against dynamic head into reservoir, \$21.08.
12. Per million gallons raised one foot high (dynamic), \$0,0667.

Cost of pumping figured on total maintenance,
 \$23,916.13.

13. Per million gallons raised against dynamic head into reservoir, \$105.38.

14. Per million gallons raised one foot high (dynamic),
\$0.333.

FINANCIAL.

Receipts.	Maintenance.		Disbursements.
Division I.			
From Consumers:			
A. Water rates, domestic.....	\$25,351 57	AA. Management and re- pairs.....	\$11,274 13
B. Water rates, manufacturing.....	2,061 95	BB. Interest on Bonds.....	12,642 00
C. Net receipts for water.....	27,313 52	CC. Total maintenance for year.....	\$33,916 13
D. Misc., coal, etc.....	1,089 13	DD. Balance to City Treas- ury.....	6,030 52
E. Total.....	\$28,352 65		
From Public Funds:			
F. Hydrants.....	\$1,200 00		
G. Fountains and Parks.....	75 00		
H. Watering Troughs.....	250 00		
I. Public Buildings.....	60 00		
	\$ 1,594 00		
K. Gross receipts, all sources....	\$29,946 65	EE. Total.....	\$29,946 65

Division II.

From fixed rates	L. Domestic.....	\$19,290 95	
	M. Manufacturing....	351 88	
	N.....		\$19,642 83
From meter rates	O. Domestic.....	\$ 5,960 62	
	P. Manufacturing....	1,710 07	
	Q.....		\$ 7,670 69
			\$27,313 52

CONSTRUCTION.

T. Appropriation from tax levy, \$3,979 38	FF. Extension mains.....	\$3,003 48
U. Pipe and labor.....	GG. " services.....	1,372 04
V. Total.....	KK. Total.....	\$4,375 52
W. Cost of works to date.....		\$315,915 65
X. Bonded debt at date.....		231,500 00
*Y. Value of sinking fund at this date.....		91,600 00
Z. Rate of interest, 4 and 6 per cent.		

CONSUMPTION.

1. Estimated total population at date, 13,500.
2. " " " on lines of pipe, 13,200.
3. " " " supplied, 12,900.

*Toward paying bonded debt of city of \$426,500.00.

4. Total number gallons consumed for year, 226,961,525.
5. Passed through domestic meters, 21,131,690 gallons, or 9.3 per cent.
6. Passed through manufacturing meters, 9,496,570 gallons, or 4.2 per cent.
7. Average daily consumption, 621,812 gallons.
8. Gallons per day to each inhabitant, 46.6.
9. " " " " consumer, 48.2.
10. " " " " tap, 277.

DISTRIBUTION.

- | MAIN. | SERVICES. |
|---|--|
| 1. Kind of pipe, cement lined, cast iron, wrought iron. | 16. galvanized iron, lead. |
| 2. Size, from $\frac{1}{2}$ inch to 10 inches. | 17. From $\frac{1}{2}$ inch to 4 inches. |
| 3. Extended, 5,257 feet. | 18. 3,390 feet. |
| 4. Discontinued, 3,454 feet. | 19. 180 feet. |
| 5. Total now in use, 29.4 miles. | 20. 12.48 miles. |
| 6. Cost of repairs per mile, \$38. | 21. Service taps added, 104. |
| 7. Leaks per mile, 2.1. | 22. Number now in use, 2,243. |
| 8. Small distribution pipe less than 4 inches, total length, 27,697 feet. | 23. Average length of service, 32.7. |
| | 24. " cost " " \$13.19 |
| 9. Hydrants added, 1. | 25. Meters added, 23. |
| 10. Number now in use, 163. | 26. Number now in use, 262. |
| 11. Stop gates added, 6. | a. domestic, 227. |
| 12. Number now in use, 257. | b. manufacturing, 35. |
| 13. Small stop gates less than 4 inches, total, 67. | 27. Motors and elevators added, 1. |
| 14. Number of blow-off gates, 4. | 28. Number now in use, 6. |
| 15. Range of pressure on mains, at centre, for day and night, 70 to 85 lbs. | |

STORAGE.

Earthwork reservoir, low service, capacity 2,236,000 gallons.

Iron tank, high service, capacity 106,000 gallons.

Wm. D. Sherman
4/24/88

TWENTY-FIRST

ANNUAL REPORT

OF THE

Water Department

OF THE

CITY OF BURLINGTON, VT.,

December 31st, 1887.

BURLINGTON:
FREE PRESS ASSOCIATION.
1888.

TWENTY-FIRST
ANNUAL REPORT
OF THE
Water Department
OF THE
CITY OF BURLINGTON, VT.,
December 31st, 1887.

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1888.

CITY OF BURLINGTON, VT.

WATER DEPARTMENT.

1887.

WATER COMMITTEE.

Alderman **McKILLIP**, *Chairman*.

Alderman **SMITH**,

Alderman **WATSON**.

SUPERINTENDENT.

F. H. PARKER.

COLLECTOR.

G. D. WELLER, *City Treasurer*.

PUMPING STATION.

JOEL W. THOMAS, *Engineer*.

ALFRED J. HOWARD, *Fireman*.

FOREMAN.

WILLIAM CASSIDY.

REPORT

OF THE

Superintendent of Water Works.

To the City Council of the City of Burlington:

GENTLEMEN—The following is a statement of the receipts and disbursements of the Burlington City Water Works, from January 1 to December 31, 1887.

RECEIPTS.

From G. D. Weller, City Treasurer.....\$18,030 19

DISBURSEMENTS—CONSTRUCTION.

Service pipe and fittings.....	\$ 374 04
Labor on services.....	464 39
Cast iron pipe, packing and lead.....	1,347 91
Labor on mains.....	635 74
Gates.....	125 74
Gate and cut-off boxes.....	225 84
Incidentals.....	2 50
	\$ 3,176 16

DISBURSEMENTS—CURRENT.

Pay rolls.....	\$1,301 10
Materials for management and repairs.....	203 82
Office expenses.....	63 08
Printing, advertising and postage.....	101 10

WATER DEPARTMENT.

Superintendent	1,000 00	
Horse keeping, shoeing and repairs	223 50	
Gate and cut-off boxes	270 02	
Repair of hydrants	18 79	
Repair of tools	20 25	
Incidentals	38 65	
Replacing cement pipe {		
Cast iron pipe	1,568 19	
Labor	592 47	
Packing and lead	201 66	
Gates	22 54	
		\$ 5,625 17

PUMPING.

Pay rolls	\$2,099 65	
Supplies	173 84	
Fuel	4,322 24	
Repairs on machinery	311 66	
Repairs on buildings and grounds	106 92	
Rent of ground	75 00	
Repairs on motor	59 26	
Repairs on pier	410 77	
Incidentals	15 69	
		\$ 7,575 03

METERS.

Meters	\$1,549 62	
Repairs and freight	104 21	
		\$ 1,653 83

RECAPITULATION.

Construction	\$3,176 16	
Current	5,625 17	
Pumping	7,575 03	
Meters	1,653 83	
		\$18,030 19

FUEL SHED.

By vote of the Board of Aldermen a special appropriation was made for building a fire proof fuel shed at the pumping station, at an estimated cost of \$5,685. The cost of this shed completed was as follows:

RECEIPTS.

From G. D. Weller, City Treasurer \$5,244 29

DISBURSEMENTS.

Roof	\$3,181 31
Brick and stone work	2,138 32
Timber under foundations	40 16
Castings	64 50

\$5,424 29

Less discount for delay in erecting roof	180 00	
		\$5,244 29

We hereby certify that we have examined the vouchers and accounts of the Superintendent of City Water Works from January 1 to December 31, 1887, and find the same correct.

MICAH H. STONE,	} Auditors.
H. R. WING,	
W. C. ISHAM.	

WATER PUMPED.

1887.	Gallons.
January	19,310,100
February	17,866,475
March	19,907,700
April	17,412,750
May	18,990,025
June	18,434,075
July	23,102,725

August.....	22,156,675
September.....	18,872,800
October.....	17,175,500
November.....	15,877,300
December.....	16,005,025
Total water pumped in 1887.....	225,111,150
Total water pumped in 1886.....	226,961,525
Decrease in 1887.....	1,850,375
Average daily consumption in 1887.....	616,743
Average daily consumption in 1886.....	621,812

SERVICES.

There have been added 101 services of the following sizes :

1.....	4	inch pipe.
1.....	3	" "
5.....	2	" "
1.....	1 $\frac{1}{4}$	" "
7.....	1	" "
2.....	$\frac{3}{4}$	" "
84.....	$\frac{1}{2}$	" "

Six services have been discontinued.

MAINS.

New mains have been laid in the following streets :

WITH FOUR-INCH CAST IRON PIPE.

Bay View street, easterly from Union.....	85	feet
Clarke street pipe, extended southerly.....	192	"
Church street pipe, extended northerly to Maple street.	185	"
Johnson street, from north line Monroe to south line of		
Peru street.....	350	"
Maple street pipe, extended westerly to Church street..	210	"

St. Louis street, northerly from Archibald street.	264 feet
Spruce street pipe, extended easterly.	288 "
Ward street, westerly from Blodgett street.	146 "
Ward street, easterly from east line of North avenue. . .	190 "

WITH SIX-INCH CAST IRON PIPE.

North avenue pipe, extended northerly.	936 "
--	-------

Total length of new mains. 2,846 feet

The pipe at west end of Ward street is connected with the North avenue pipe, and the pipe in Johnson street with the pipes in Monroe and Peru streets, by small pipes until such time as the cement pipes in those streets is replaced by iron pipe, when permanent connections will be made.

The cement pipe in the following streets has been replaced this season—

WITH FOUR-INCH CAST IRON PIPE.

Church street, northerly from Adams.	430 feet
Maple street westerly from Elm.	180 "

WITH SIX-INCH CAST IRON PIPE.

Champlain street from Pearl to Peru street.	803 "
and the connection with this pipe and pipes in the intersecting streets were made at	
Peru street with four-inch pipe.	36 "
Monroe " " " "	63 "
Smith's Lane " six " "	65 "

Total length of cement pipe replaced. 1,577 feet

LENGTH OF PIPE NOW IN USE.

Cement.	97,137 "
Iron.	59,087 "
Total feet of pipe.	156,224 '
Total miles of pipe.	29.58

HYDRANTS.

The hydrants set this season are located as follows :

LOCATION.	KIND.
North avenue and North Bend, southeast corner...	Ludlow Post.
Main and Union, northeast corner.....	Lang “
Spring and Interval avenue, northwest corner.....	“ “
Central Vt. R. R. depot, at north end.....	Ludlow “
Central Vt. R. R. yard, west of engine house.....	“ “

With the exception of the first named, the above replace underground hydrants. Two underground hydrants in the railroad yard north of the depot were removed at the request of the railroad company.

Total number public hydrants.....	142
Total number private hydrants.....	20
Total.....	162

GATES.

The following old gates on cement pipe have been removed :

Champlain at Pearl.....	1	6-inch
Monroe at Champlain.....	2	3 “
Peru at Champlain.....	1	3 “
Smith's Lane at Champlain.....	1	6 “
Total removed.....	5	

The following gates have been set this season :

Champlain at north line Pearl....	1	6-inch
Champlain at south line Pearl.....	1	6 “
Champlain at north line Peru.....	1	6 “
Church at north line Adams....	1	4 “
Maple at west line Elm.....	1	4 “
Monroe at east line Champlain.....	1	4 “
Monroe at west line Champlain.....	1	4 “

Peru at east line Champlain.....	1	4-inch
Smith's Lane at west line Champlain.....	1	6 "
St. Louis at north line Archibald.....	1	4 "
Blow-off at foot of College street.....	1	4 "
Total added.....	11	
Total number of gates now in use	263	

CURRENT.

The repairs for the year have been

On cement pipe.....	10	breaks
" " "	9	leaks
" iron pipe.....	6	"
" service pipes.....	11	"
" broken hydrants.....	4	

One hundred and sixty iron stop boxes and thirty eight iron gate boxes have been set to replace old wooden boxes.

PUMPING.

The amount of water pumped is slightly less than in 1886 and about the same as in 1883, although it might naturally have been more, considering the additional number of services and the increase in length of sewers, were it not for the increase in the number of meters.

As the number of meters increase, the amount of water leaving the reservoir at night, which is principally wasted, decreases.

The timber work of the pier at the pumping station has been rebuilt above low water, filled with stone, planked on top and now instead of joining the dock front, it is separated from it by a space of four feet. The pump wells are by this change surrounded by water, that is so agitated by the waves that the accumulation of floating matter at this point is now avoided and a much more creditable appearance is presented.

An additional plot of land 50x100 feet adjoining our former lot, has been leased, upon which has been built a new fire-proof fuel shed, a substantial brick building with stone foundation 40x97½ feet, covered with an iron roof and connected with the boiler-room by a short passage. A track for a coal-car which runs through the center of this building at the height of the side walls is supported entirely by the roof trusses, and from the face of the building to the scales at the dock front by an iron trestle.

The old shed fell down on removing the side boarding, and the space it occupied has been enclosed by a high fence and will be used as a pipe-yard, and the open lot will be a protection to the engine room in case of fire among the adjoining lumber sheds. Shavings have been used for fuel 35 weeks and consequently we have a larger supply of coal on hand than usual at this time. The pumps have had a general overhauling, all needed repairs have been made and they are in good order.

METERS.

There are now in use 374 meters, an increase of 112 over last year.

Of this number 262 are owned by individuals ; 112 are the property of the department, of which number 51 are rented under the regulations adopted in May.

There has passed through the meters 33,335,752 gallons of water, the bills for which amount to \$9734.15, or practically 15 per cent of the water pumped has yielded 32 per cent of the revenue. Although the meter rates were reduced from June 1st, this is an increased percentage over last year, owing to the large increase in house meters, which pay the highest rate, and the total water collections show a gain of \$1733.76 over 1886.

Respectfully submitted,

F. H. PARKER,

Superintendent.

RULES AND REGULATIONS

Burlington City Water Works.

ADOPTED BY CITY COUNCIL, MAY 2d, 1887.

Applications for water must be made at the Superintendent's office, and must be signed by the owner of the premises to be supplied, or his or her duly authorized agent, and must state the use for which the service is desired.

All premises are entitled to a service pipe $\frac{1}{2}$ inch in diameter to the line of the street, at the expense of the city, and larger services will be furnished for fire purposes or where a meter is to be used, on property holders paying the increased cost.

When two or more take water through one service pipe, the ordinance in regard to cutting off the supply shall be applicable to all, although one or more shall be innocent of any cause of offense.

Outside faucets or yard hydrants for the supply of families, not allowed unless kept in perfect repair.

No person shall be entitled to damages, nor to have any portion of a payment refunded, for any stoppage of supply occasioned by accident to any portion of the works; for stoppage for addition or repairs, or for non-use occasioned by absence.

All persons taking water must keep the fixtures and service pipe within their own premises in good repair and fully protected from frost, and must prevent all unnecessary waste of water, unless supplied through a meter.

No charge will be made for water from private hydrants that may be erected and used in case of fire, but any other use of such hydrants is prohibited.

Consumers who desire to take water through a meter rather than at schedule rates, can do so on paying the cost of such meter as shall be approved by the Superintendent, together with the cost of putting in and maintaining the same in perfect repair.

Meters with $\frac{1}{2}$ inch delivery will be furnished any property holder under the following conditions: The place of setting the meter shall be satisfactory to, and approved by the Superintendent; the cost of such setting and any damage to the meter by frost or improper usage shall be paid by the property holder, and the sum of \$2.00 shall be paid annually in advance to the city to cover interest, maintenance and repairs.

Meters larger than $\frac{1}{2}$ inch delivery will be furnished under similar conditions, on property holders paying an increased rent based on the extra cost of the larger meter.

Persons using meters must connect all the fixtures supplied with water on their premises with such meters, so that all the water used will be measured, and all water passing through meters must be paid for whether used or wasted.

Water used through two or more meters upon the same premises, for the same business, or to supply the same pipes used for a common supply, shall be rated as passing through one meter; if used through separate pipes for different kinds of business, each meter shall be rated separately.

Premises of different individuals shall not be supplied through one meter

If from any cause a meter fails to register the amount of water passing through it, the consumer will be charged at the average daily rate as shown by the meter when in order.

The city reserves the right to put in a meter at their own expense, and charge for measured water instead of schedule rates.

Meter rates payable quarterly, and in no case where a meter is used shall the annual charge for water be less than ten dollars.

The use of hose for any purpose more than two hours a day, the use of nozzles larger than $\frac{1}{4}$ inch in diameter, the use of fountains and lawn sprinklers after dark, and the use of fixtures with a constant flow are forbidden, unless the premises where such fixtures are used are supplied through meters.

Attention is called to the penal clauses of sections 4, 5, 6, 7, 8, 13, 14 and 15 of the revised ordinances in relation to the Water Department.

YEARLY WATER RATES.

For one family, one faucet.....	\$ 7 00
“ each additional faucet.....	1 00
“ two families using one faucet, each....	6 00
“ three or more families using one faucet, each.....	5 00
“ one water closet.....	4 00
“ each additional water closet.....	2 00
“ urinals, each.....	4 00
“ one bath-tub.....	4 00
“ each additional bath-tub.....	2 00
“ drug stores, each.....	10 00
“ grocery stores, each.....	7 00
“ dry goods stores, each.....	6 00
“ offices in detached building, one faucet, each.....	6 00
“ offices in a block, one faucet, each.....	4 00
“ two or more offices using one water-closet or urinal, each.....	3 00
“ churches and schools, one faucet, each.....	7 00
“ barber shop, one chair.....	6 00
“ each additional chair.....	1 00
“ blacksmith shop.....	6 00
“ steam boiler, meter rate.....	
“ private horses, each.....	3 00
For truck horses, each.....	\$2 00
“ livery and boarding horses, each.....	3 00
“ hose for garden, etc., not to exceed $\frac{1}{2}$ inch nozzle, two hours each day.....	4 00
“ cows, each, payable December collection.....	1 50
“ brick laying per M.....	05
“ stone “ “ perch.....	01 $\frac{1}{2}$
“ plastering “ 100 yards.....	25

MONTHLY METER RATES.

Under 1,000 cubic feet.....	30c. per 100 feet
Over 1,000 and under 2,000 cubic feet.....	25c. “ “ “
“ 2,000 “ “ 4,000 “ “.....	20c. “ “ “
“ 4,000 “ “ 6,000 “ “.....	15c. “ “ “
“ 6,000 “ “ 10,000 “ “.....	12c. “ “ “
“ 10,000 “ “ 20,000 “ “.....	11c. “ “ “
“ 20,000 “ “.....	10c. “ “ “

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by city census, 1885, 13,357.

Works constructed, 1867-8.

Owned by city.

Source of supply, **Lake Champlain.**

Mode of supply, **pumping.**

PUMPING.

1. Builders of pumping machinery.....H. R. Worthington.
 2. Description

<ol style="list-style-type: none"> a. Anthracite. c. Grate. d. Pittston. e. \$5.44. g. Mill shavings, \$38.50 per week, 35 weeks. 	}	17 weeks.
--	---	-----------

 of fuel.
 6. Total pumpage for the year, 225,111,150 gallons.
 7. Average static head against which pumps work, 289 feet.
 8. Average dynamic head against which pumps work, 316 feet.
- Cost of pumping figured on pumping station expenses,*
\$7,575.03.
11. Per million gallons raised against dynamic head into reservoir, \$33.65.
 12. Per million gallons raised one foot high (dynamic), \$0.1065.
- Cost of pumping figured on total maintenance,*
\$24,690.20.
13. Per million gallons raised against dynamic head into reservoir, \$109.72.
 14. Per million gallons raised one foot high (dynamic), \$0.347.

FINANCIAL.

Division I.

Receipts.	Maintenance.	Disbursements.	
From Consumers:			
A. Water rates, domestic.....	\$25,707 22	AA. Management and repairs.....	\$13,200 20
B. Water rates, manufacturing.....	3,340 06	BB. Interest on Bonds.....	11,490 00
C. Net receipts for water	29,047 28	CC. Total maintenance for year.....	\$24,690 20
D. Mis. "	19 27	DD. Balance to City Treasury.....	5,970 35
E. Total	29,066 55		
From Public Funds:			
F. Hydrants.....	\$1,200 00		
G. Fountains and Parks.....	75 00		
H. Watering Troughs.....	250 08		
I. Public Buildings.....	69 00		
	\$ 1,594 00		
K. Gross receipts, all sources.....	\$30,660 55	EE. Total	\$30,660 55

Division II.

From fixed rates	{ L. Domestic.....	\$19,134 13
	{ M. Manufacturing.....	179 00
	N.	\$19,313 13
From meter rates	{ O. Domestic.....	\$ 6,573 09
	{ P. Manufacturing.....	3,161 06
	Q.	\$ 9,734 15
		\$29,047 28

CONSTRUCTION.

T. Appropriation from tax levy..	\$7,770 33	FF. Extension mains.....	\$2,163 73
U. Pipe and labor.....	650 12	GG. " services.....	1,013 43
V. Total	\$8,420 45	HH. Fuel shed	5,344 29
		KK. Total.....	\$8,420 45
W. Cost of works to date.....			\$324,351 10
X. Bonded debt at date.....			231,500 00
*Y. Value of sinking fund at this date.....			97,850 00
Z. Rate of interest, 4 and 6 per cent.			

CONSUMPTION.

1. Estimated total population at date, 14,000.
2. " " " on lines of pipe, 13,700.
3. " " " supplied, 13,400.
4. Total number gallons consumed for year, 225,111,150.

*Toward paying bonded debt of city of \$426,500.00.

5. Passed through domestic meters, 22,439,200 gallons, or 9.9 per cent.
6. Passed through manufacturing meters, 9,496,570 gallons, or 4.8 per cent.
7. Average daily consumption, 616,743 gallons.
8. Gallons per day to each inhabitant, 44.
9. " " " " " consumer, 46.
10. " " " " " tap, 263.

DISTRIBUTION.

MAIN.	SERVICES.
1 Kind of pipe, cement lined, cast iron, wrought iron.	16. galvanized iron, lead.
2 Size, from $\frac{1}{2}$ inch to 10 inches.	17. From $\frac{1}{2}$ inch to 4 inches.
3. Extended, 4,423 feet.	18. 2,638 feet.
4. Discontinued, 1,577 feet.	19. 146 feet.
5. Total now in use, 29.58 miles.	20. 12.95 miles.
6. Cost of repairs per mile, \$20.30.	21. Service taps added, 101.
7. Leaks per mile, 1.2.	22. Number now in use, 2,338.
8. Small distribution pipe less than 4 inches, total length, 27,697 feet.	23. Average length of service, 27.2.
	24. " cost " " \$10.34.
9. Hydrants added, 1.	25. Meters added, 112.
10. Number now in use, 162.	26. Number now in use, 374.
11. Stop gates added, 6.	a. domestic, 338.
12. Number now in use, 263.	b. manufacturing, 36.
13. Small stop gates less than 4 inches, total, 67.	27. Motors and elevators added, 1.
	28. Number now in use, 7.
14. Number of blow-off gates, 5.	
15. Range of pressure on mains, at centre, for day and night, 70 to 85 lbs.	

STORAGE.

Earthwork reservoir, low service, capacity 2,236,000 gallons.

Iron tank, high service, capacity 106,000 gallons.

CITY ORDINANCE.

REVISION OF 1888.

CHAPTER I.

WATER DEPARTMENT.

It is hereby ordained by the City Council of the City of Burlington as follows:

SEC. 1. Duties of superintendent of water works.

SEC. 2. Superintendent to make monthly statement of expenses to Board of Aldermen.

SEC. 3. Superintendent to give notice before shutting off supply of water from hydrants.

SEC. 4. When water is to be shut off from any line of pipes, takers to be notified.

SEC. 5. Superintendent to have an examination made of hydrants and fire plugs belonging to city.

SEC. 6. City Council to prescribe rules and regulations for government of water works.

SEC. 7. Rates to be fixed by committee of Board of Aldermen. Service rates to be paid six months in advance; unless rates are paid on or before the 10th of June and December, superintendent to cut off water from premises.

SEC. 8. Additions and alterations of pipes; how made.

SEC. 9. Water may be cut off from premises of any person misusing or giving it away.

SEC. 10. No person from whose premises the water has been shut off, shall let it on or use city water from other sources, unless by direction of superintendent.

SEC. 11. Hydrants not to be opened, except by superintendent, committee, or chief engineer, or fire companies for fire purposes.

SEC. 12. Mains tapped and lateral pipes laid by city to street line.

SEC. 13. Injuring building, hydrant, fence or apparatus connected with city water works.

SEC. 14. Putting or throwing anything into reservoir or city water.

SEC. 15. Watering animals at trough, to evade tax.

SEC. 16. Penalty for violating provisions of this chapter.

SEC. 1. The superintendent of the city water works shall have the general supervision of the water works belonging to the city, under such regulations as may from time to time be prescribed by the City Council, and shall have the right at all times to enter the premises of any person using the water, for the purpose of examining the pipe or other apparatus connected with the service pipe, and the manner in which water is used on such premises.

Duties of superintendent.

Superintendent to make monthly statement of expenses to board.

SEC. 2. The superintendent of the city water works shall, at the end of each month, make up an account in detail of the expenses of the same, together with a statement of the outstanding liabilities for such month, to be approved by the water committee, and shall present the same to the Board of Aldermen on or before the regular meeting of the board for the succeeding month.

Superintendent to give notice before shutting off supply from hydrants.

SEC. 3. The superintendent of the city water works, and in case of his absence, the person or persons acting in his stead, whenever he or they shall cut off the supply from any of the hydrants or fire plugs in any part of the city, for repairs or other proper causes, and he or they shall find it necessary to keep the supply of water shut off therefrom over night of the day when so shut off, shall immediately give notice thereof to the chief engineer of the fire department, or in the absence of the chief engineer from the city, to the assistant engineer of the fire department residing nearest to the hydrants or fire plugs so cut off; and he or they shall state in the notice particularly to what extent the hydrants and fire plugs are so rendered unavailable for fire service; and shall also notify said chief engineer or assistant engineer when the said hydrants and fire plugs are again in working order; and in order that no failure to receive such notice by the fire department shall occur, the said superintendent, or person in charge of said city water works in his absence, shall give the notices as aforesaid, either in person or by special messenger.

Takers to be notified when water is shut off.

SEC. 4. When the said superintendent shall have cause to shut off the supply of water on any line of pipe for repairs, he shall immediately notify the water takers on the line of pipe to be shut off, stating as nearly as

possible the length of time such supply will be shut off; provided, however, in case of sudden bursts, the water may be shut off without notice.

Sec. 5. The said superintendent shall have an examination made of the hydrants and fire plugs belonging to the city, from time to time, and keep them in working order at all times, except when shut off for repairs; and shall cause all defects therein to be repaired without delay.

City hydrants and fire plugs to be kept in order.

Sec. 6. The City Council shall prescribe rules and regulations for the government of the city water works, and may from time to time, by resolution or otherwise, adopt such pipe or other apparatus for the use of the city water works as they shall deem advisable.

City Council to prescribe rules and regulations for government of water works.

Sec. 7. The water committee of the Board of Aldermen shall have power to fix all regular, meter and special service rates from time to time, subject to the approval of the City Council. The regular service rates for water shall begin on the first days of June and December, in each year, and shall be paid in advance for the term of six months, and shall be payable to and collected by the city treasurer at his office. He shall have the premises of all persons using water from the city water works inspected between the first and twentieth days of May and November in each year, and shall have the pipes and other fixtures connected with the service pipe examined, and see that the water on such premises is used according to the ordinances, rules and regulations of the water department, and make a tax bill of all meter and special rates on or before the first days of March, June, September and December.

Service rates to be fixed by Board of Aldermen.

To be paid six months in advance.

Delinquents
reported.

If the regular service rates are not paid on or before the tenth days of June and December respectively, and the special service or meter rates on or before the tenth days of March, June, September and December, respectively, the city treasurer shall notify all delinquents whose rates remain unpaid at that time, that unless immediate payment is made he will order the superintendent of the city water works to cut off the water from the premises of such delinquent, until such regular, special or meter rates due from such delinquent, with five per cent in addition thereto, are paid to the city treasurer, together with the sum of one dollar for cutting off and turning on the water; and the said superintendent shall immediately execute any such order of the treasurer.

Additions
and alterations
of
pipes, how
made.

SEC. 8. No person shall use the water supplied by the city water works, tap the mains, or any pipe leading from the same, or attach any pipe thereto, or make any extension or alterations of or additions to the service pipe upon his premises, without first applying to the superintendent of the city water works, at his office, and signing an application for the same, stating the purpose for which he desires to use the water. No plumber or any other person shall connect any water closet, bath tub, fountain, machinery, faucet or any other apparatus whatever with the city water works without first obtaining permission in writing so to do from the superintendent of the city water works, and it shall be the duty of the superintendent, whenever any such permits shall have been given by him, to report the same to the city treasurer immediately thereafter.

SEC. 9. No person shall give away or use any

water from the city water works on any premises, for any other purpose than that for which payment has been made; nor allow the water to be wasted from fixtures out of repair or otherwise. The superintendent of the city water works, or his authorized agents, shall immediately cut off the water from the premises of any person who shall violate any of the provisions of this section, and such offender shall be deprived of the use of the water until he shall have paid to the city treasurer for the use of the city, the sum of one dollar for cutting off and turning on the water, and shall have made all necessary repairs.

When water may be cut off.

SEC. 10. No person upon any premises where a regular water rate is assessed, or who shall take water by special or meter rates, after the water shall have been shut off for cause, as is provided in sections seven and nine of this chapter, shall let on the water, or let the water run from the pipes on such premises, or authorize, cause or permit the water to be let on, or draw or use any water from the city water works, on the premises of any other person, with or without the permission of such person, unless the same be done by or under the direction of the superintendent of the city water works.

When cut off, not to be let on or used without permit.

SEC. 11. No person shall open any hydrant or fire plug, or draw water therefrom, excepting the water committee or the superintendent, or persons under their direction, or the chief engineer of the fire department, and members of fire companies under his direction, for fire purposes.

Hydrants or fire plugs opened only by authorized person.

SEC. 12. The mains shall be tapped and all lateral pipes laid by the city to the line of the street, the city

Pipes laid by city.

furnishing the stop-cock and box and keeping the same at all times in repair, extraordinaries excepted; but the city will not be accountable for obstructions by frost or otherwise, or for leakage of hydrants or pipes, and damages thereby, upon the premises of individuals.

Injuries to
water build-
ing or appar-
atus.

SEC. 13. No person shall remove, carry off, or in any way injure any hydrant, valve, valve box or cover, stop cock, stop-box or cover, pipe, tool, apparatus, fixture, building, machinery or fence, belonging to the city water works.

Putting any-
thing into
reservoir or
city water.

SEC. 14. No person shall throw, put or place, or cause to be thrown, put or placed, in any public reservoir or watering trough, or the water thereof in the city, any stone, dirt, ashes, shavings, sticks, garbage, rubbish or filth of any kind, nor shall wade or bathe in, or cause or permit a dog or other animal to go into or swim in the water of a public reservoir or watering trough in the city.

Using water
to evade tax.

SEC. 15. No person shall water a horse or cow or other animal at any of the public watering troughs of the city, or use any water therefrom, for the purpose of evading the payment of the regular rates charged by the city for the use of water in like cases, or with intent thereby to defraud the city of its lawful revenues.

Penalty.

SEC. 16. A person who shall violate any of the provisions of this chapter shall be punished by a fine of not more than fifty dollars nor less than two dollars.

TWENTY-SECOND

ANNUAL REPORT

OF THE

Water Department

OF THE

CITY OF BURLINGTON, VT.,

December 31st, 1888.

BURLINGTON:
FREE PRESS ASSOCIATION.
1889.

1821 254*

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TWENTY-SECOND

ANNUAL REPORT

OF THE

Water Department

OF THE

CITY OF BURLINGTON, VT.,

December 31st, 1889.

BURLINGTON:
FREE PRESS ASSOCIATION.

1889.

REPORT

OF THE

Superintendent of Water Works.

FRANK H. PARKER, *Superintendent.*

JANUARY 1 TO APRIL 25, 1888.

To the City Council of the City of Burlington:

GENTLEMEN—The following is a statement of the receipts and disbursements of the Burlington City Water Works, from January 1 to April 25, 1888:

RECEIPTS.

From D. D. Weller, City Treasurer.....\$2,998 37

DISBURSEMENTS—CONSTRUCTION.

Service pipe and fittings.....	\$ 57 77
Pay rolls for labor.....	17 65
Addition to buildings.....	389 00
	<hr/> \$ 464 42

CURRENT.

Pay rolls.....	\$406 12
Repair hydrants.....	14 14
Hydrants.....	124 00
Cut-off boxes.....	31 58
Repair tools.....	3 75
Superintendent.....	316 64

Advertising and printing.....	30 00
Horse keeping and repairs.....	96 25
Office expenses.....	39 46
Materials for management and repairs.....	95 47
	<hr/> \$1,157 41

PUMPING.

Pay rolls.....	\$560 50
Rent of ground.....	100 00
Repairs of machinery.....	185 28
Supplies	107 39
	<hr/> \$ 953 17

METERS.

Meters.....	\$413 96
Freight and repairs.....	9 41
	<hr/> \$ 423 37

RECAPITULATION.

Construction.....	\$ 464 42
Current.....	1,157 41
Pumping.....	953 17
Meters.....	423 37
	<hr/> \$2,998 37

We, the undersigned Auditors of the City of Burlington, certify that we have examined the vouchers, books and accounts of the Superintendent of the City Water Works from January 1 to April 25, 1888, and find the same correct.

MICAH H. STONE,	} <i>Auditors.</i>
H. R. WING,	
W. C. ISHAM,	

Respectfully submitted,

F. H. PARKER,

Superintendent.

REPORT

OF THE

Superintendent of Water Works.

FRANK H. CRANDALL, Superintendent.

April 25th, 1888, to January 1st, 1889.

To the City Council of the City of Burlington :

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works, from April 25th to December 31st, 1888.

RECEIPTS.

From G. D. Weller City Treasurer.....\$16,227 94

DISBURSEMENTS—CONSTRUCTION.

Service pipe and fittings.....	\$ 407 44
Labor on Services.....	539 17
Cast iron pipe, packing and lead.....	1,217 09
Labor on mains.....	556 77
Hydrants.....	68 00
Gates.....	33 00
Gate and cut off boxes.....	221 41
Higher service pump.....	345 00
Incidentals.....	4 00
	\$3,391 88

CURRENT.

Pay rolls.....	\$1,461	29
Materials for management and repairs.....	202	38
Office expenses.....	62	80
Printing, advertising and postage.....	50	80
Superintendent.....	666	64
Horse keeping, shoeing and repairs.....	160	12
Gate and cut-off boxes.....	553	94
Repair of hydrants.....	96	75
Repair of tools.....	22	25
Incidentals.....	26	65
Replacing cement pipe, Cast iron pipe.....	2,069	40
Labor.....	912	93
Packing, lead and stops.....	460	46
Gates.....	372	44
	<u>\$</u>	7,118 85

PUMPING.

Pay rolls.....	\$ 1,474	53
Supplies.....	101	37
Fuel	2,526	00
Repairs on Machinery.....	201	17
Repairs on buildings and grounds.....	129	93
Insurance.....	90	00
Repairs on motor.....	9	10
Incidentals.....		20
	<u>\$</u>	4,537 30

METERS.

Meters.....	\$ 1,172	60
Repairs and freight... ..	7	31
	<u>\$</u>	1,179 91

RECAPITULATION.

Construction.....	\$ 3,391	88
Current	7,118	85
Pumping	4,537	30
Meters	1,179	91
	<u>\$</u>	16,227 94

RESERVOIRS.

At a meeting of the Board of Aldermen, held April 20, 1888, the following resolution, offered by Aldermen Brown, Chairman of the Water Committee, was adopted:

“Whereas, The present reservoir, under the system of water supply in use in the city, is hardly of sufficient capacity in the event of extensive fires, and has been shown, upon recent and repeated inspection, to be badly out of repair and in great need of cleansing, and to demand immediate and extensive improvements which cannot be made without emptying the reservoir of water, and having it empty for a considerable time, and so greatly imperiling the safety of property, and

“Whereas, Our city needs and should have a reservoir, which will permit of a constant change, circulation and freshening of water used by the public for drinking, which is not now possible under the present system. Therefore

“Resolved, That it is the sense of the City Council that a sum, not exceeding \$25,000 to be obtained either from taxes, assessed by the City Council, or from a pledge of the credit of the city, should be appropriated for the construction of an additional reservoir, and the proper repair of the existing one, upon such plan as the committee of the Water Department, in its discretion, may adopt; and that said committee should proceed to construct such reservoir, and make such repairs from the moneys which may be appropriated as aforesaid.”

For the purpose of ascertaining whether the city preferred to authorize the pledge of the credit of the city for this sum rather than raise it by a direct tax, a city meeting was called by the Mayor on the 8th of May last. At this meeting the following resolution was adopted:

“Resolved, That the City Council of the City of Burlington are hereby authorized to pledge the credit of the city for a loan not exceeding twenty-five thousand dollars (\$25,000) payable in instalments not extending beyond ten years, for the pur-

"pose of building a new reservoir and repairing the present "one."

After a considerable delay, occasioned by the desire to build a cheaper and therefore smaller reservoir than the one previously contemplated, it being found that the capacity and general utility decreased much more rapidly than the cost, it was finally decided to build the four-million gallon reservoir, for which plans and specifications were prepared by Superintendent Parker two years ago. Bids were asked for, and the contract awarded to Messrs. W. H. Lang, Goodhue & Co., of this city, the lowest bidders.

The Parker Reservoir is so proportioned as to shape and size, as to occupy the entire available space south of the old Reservoir on the lot at present owned by the city, and in proportion to its capacity is much the cheapest that could be built upon that lot.

The material to be excavated was generally thought to be a hard-pan, next door to bed-rock, and for the last few feet it came fully up to the general expectation.

The new Reservoir has a concrete bottom, and its sides for two thirds the distance from the bottom are lined with brick laid in cement. The upper third, on which fluctuation occurs is covered with blocks of Barre granite of sufficient size to resist the action of the ice, making a reservoir in which there is no chance for the accumulation of vegetable growth, and which may at any time be drawn off and thoroughly cleaned.

A portion of the waste material from the excavation of the new reservoir has been used to raise and strengthen the banks of the old.

Some pipes and castings have been procured ; further than this nothing has as yet been done toward the repairs of the old reservoir.

With the old reservoir placed on equally good footing with the new, and the two connected, as is proposed, in such a manner as to admit of the use of the two together, or either independently

we are in possession of a clean storage basin of nearly treble our former capacity, with all the necessary facilities for keeping it so without in any way interfering with the efficiency of our fire protection.

Work was begun on the new reservoir during the latter part of June, and though as yet not wholly completed, is so far advanced that we have been able to permanently discontinue the use of the old reservoir.

That this was accomplished in spite of the lateness of commencing the work, and an unprecedentedly wet season, is largely due to the untiring efforts and personal supervision of Mr. W. H. Lang, of the contracting firm.

The following is a statement of the receipts and disbursements of the special appropriation made for reservoirs.

RECEIPTS.

From G. D. Weller, City Treasurer.....\$21,127 55

DISBURSEMENTS—NEW RESERVOIR.

Contractor.....	\$18,000 00	
Pipes and castings....	1,291 47	
Step at base of slope.....	441 50	
Inspection and labor.....	780 09	
Eight-inch tile and plank.....	120 20	
Brick.....	52 00	
Freight and cartage.....	44 46	
Printing and advertising.....	31 89	
		<u>\$20,770 61</u>

OLD RESERVOIR.

Retaining wall.....	\$ 80 69	
Pipes and castings.....	276 25	
		<u>\$ 356 94</u>
Total.....		<u>\$21,127 55</u>

We hereby certify we have examined the vouchers and accounts of F. H. Crandall, Superintendent of Water Works, from April 25, 1888, to January 1, 1889, and find the same correct.

MICAH H. STONE,
H. R. WING,
W. C. ISHAM, } *Auditors.*

WATER PUMPED.

1888.	<i>Gallons.</i>
January.....	18,993,950
February.....	20,259,200
March.....	19,751,150
April.....	16,407,075
May.....	18,826,500
June.....	23,330,025
July.....	25,687,250
August.....	23,127,725
September.....	21,089,025
October.....	22,218,925
November.....	22,615,325
December.....	22,054,125
Total water pumped in 1888.....	254,360,275
Total water pumped in 1887.....	225,111,150
Increase in 1888.....	29,249,125
Average daily consumption in 1888.....	696,877
Average daily consumption in 1887.....	616,743

SERVICES.

There have been added 105 services of the following sizes:

4.....	2	inch pipe.
1.....	1½	" "
1.....	1½	" "
1.....	1	" "
5.....	¾	" "
93.....	½	" "

Five services have been discontinued.

MAINS.

New mains have been laid on the following streets :

WITH FOUR-INCH CAST-IRON PIPE.

Centre street, southerly from Bank street.....	300 feet.
Haswell street, westerly from North avenue.....	220 "
South Willard street, extending southerly.....	180 "
Bissell street, northerly from Haswell street.....	245 "
Hickok street, easterly from North Union street.....	338 "
Buell street, westerly from South Willard street.....	198 "
Oak street, westerly from Interval avenue.....	198 "
Clarke street, extended southerly.....	82 "

WITH SIX-INCH CAST-IRON PIPE.

North Willard street, northerly from Pearl street.....	912 "
--	-------

Total length of new mains.....2,673 feet.

The Buell street pipe is connected with the South Willard street pipe, the Hickok street with the North Union street pipe, and the Haswell street with the North avenue pipe by small pipes, until such time as the cement pipes of those streets shall be replaced by iron pipe, when permanent connections will be made.

The cement pipe in the following streets has been replaced this season :

WITH FOUR-INCH CAST-IRON PIPE.

Decatur street, westerly from North Winooski avenue..	549 feet.
Elm street, from Maple street to Adams street.....	540 "

WITH SIX-INCH CAST-IRON PIPE.

Champlain street, extended northerly to North street..	680 "
Battery street, from Bank street to Pearl street.....	830 "

WITH TEN-INCH CAST-IRON PIPE.

Battery street, from Pearl street to Battery Place.....	630 "
---	-------

Connections with the Battery street pipe in the intersecting streets were made at

Bank street, with four-inch pipe.....	43 feet.
Cherry street, with four-inch pipe.....	62 "

Total length of cement pipe replaced.....3,334 feet.

The four-inch cast-iron pipe on Pearl street, between Champlain and Battery streets, has this season been replaced with a ten-inch cast-iron pipe.

LENGTH OF PIPE NOW IN USE.

Cement.....	93,803 feet.
Iron.....	65,094 "

Total feet of pipe.....158,897 feet.

Total miles of pipe.....30.09 miles.

HYDRANTS.

There have been three hydrants set this season.

LOCATION.	KIND.
Corner North and Union streets.....	Lang Post.
Corner Decatur street and North Winooski avenue...	" "
Corner Interval avenue and Oak street.....	" "

With the exception of the last named, the above replace underground hydrants.

Total number of public hydrants.....143

Total number of private hydrants.....20

Total.....163

GATES.

The following old gates on cement pipe have been removed :

Battery at College.....	1	5-inch.
Battery at Bank.....	2	4 "
Battery at Pearl.....	2	5 "
Monroe at Battery.....	1	4 "

Pearl at Battery.....	1	4-inch.
Cherry at Battery.....	1	3 "
Decatur at Winooski avenue.....	1	4 "
Elm at Adams.....	1	4 "
Elm at Maple.....	1	4 "
Pearl at Church.....	1	6 "
<hr/>		
Total removed.....	12	

The following gates have been set this season :

Battery at south line of Smith's lane.....	1	10-inch.
Battery at north line of Pearl.....	1	10 "
Pearl at east line of Battery.....	1	10 "
Battery at south line of Pearl.....	1	6 "
Battery at south line of Bank.....	1	6 "
Willard at north line of Pearl.	1	6 "
Willard at south line of Pearl.....	1	6 "
Champlain at south line of North.....	1	6 "
Monroe at east line of Battery.....	1	4 "
Cherry at east line of Battery.....	1	4 "
Bank at east line of Battery.....	1	4 "
Decatur at west line of Winooski avenue.....	1	4 "
Elm at south line of Maple.....	1	4 "
Oak at west line of Interval avenue.....	1	4 "
Elm at north line of Adams.....	1	4 "
<hr/>		
Total added.....	15	

Total number of gates now in use.....266

CURRENT.

The repairs since April 25th have been :

On cement pipe.....	6 breaks.
" " "	6 leaks.
" " "	2 pick holes.
On iron pipe.....	3 leaks.

On service pipes..... 6 leaks.
On broken hydrants.....10

Ninety-four iron stop boxes and eleven iron gate boxes have been set to replace old wooden ones.

METERS.

There are now in use 445 meters, an increase of 71 over last year.

Of the water pumped 16.3 per cent. has been used through meters, yielding 30.6 per cent. of the collections.

The unusual amount of sickness in our city for some time past has again called public attention to the purity of our source of water supply. Various plans for its improvement have, for some time past, been under consideration by the Water Committee, under whose direction estimates have been made of the cost, and investigations are now in progress as to the relative merits of different sources of supply.

Respectfully submitted,

F. H. CRANDALL,

Superintendent.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by city census, 1885, 13,357.

Works constructed, 1867-8.

Owned by city.

Source of supply, Lake Champlain.

Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery.....H. R. Worthington.
2. Description

$\left\{ \begin{array}{l} a. \text{ Anthracite.} \\ c. \text{ Grate.} \\ d. \text{ Pittston.} \\ e. \text{ \$4.65.} \\ g. \text{ Mill shavings, \$38.50 per week, 24 weeks.} \end{array} \right.$	}	28 weeks.
---	---	-----------

of fuel.
6. Total pumpage for the year, 254,360,275 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
- Cost of pumping figured on pumping station expenses,*
\$5,490.47.
11. Per million gallons raised against dynamic head into reservoir, \$21.58.
12. Per million gallons raised one foot high (dynamic), \$0.0683.

*Cost of pumping figured on total maintenance.***\$24,957.73.**

13. Per million gallons raised against dynamic head into reservoir, \$98.11.
14. Per million gallons raised one foot high (dynamic), \$0.31.

FINANCIAL.**Division 1.**

Receipts	Maintenance.	Disbursements.
From Consumers:		AA. Management and repairs..... \$18,766 73
A. Water rates, domestic..... \$28,853.45		BB. Interest on Bonds..... 11,191 00
B. Water rates, manufacturing..... 2,652.55		CC. Total maintenance for year..... 24,957 73
C. Net receipts for water..... \$31,506.00		DD. Balance to the City Treasury..... 8,142 27
E. Total.....		
From Public Funds:		
F. Hydrants..... \$1,200 00		
G. Fountains and Parks..... 75 00		
H. Watering Troughs..... 250 00		
I. Public Buildings..... 69 00	.... \$ 1,594 00	
K. Gross receipts, all sources..... \$33,100 00		EE. Total..... \$33,100 00

Division II.

From fixed rates	{ L. Domestic..... \$21,361 97	
	{ M. Manufacturing.... 112 00	
	N.....	\$21,473 97
From meter rates	{ O. Domestic..... \$7,491 48	
	{ P. Manufacturing.... 2,540 55	
	Q.....	\$10,032 03
	Total.....	\$31,506 00

CONSTRUCTION.

T. Appropriation from tax levy.. \$23,836 53	FF. Extension mains..... \$2,162 73
U. Pipe and labor..... 623 85	GG. Extension services..... 1,013 43
V. Total..... \$24,510 48	HH. Reservoir..... 5,244 29
	KK. Total..... \$8,420 45
W. Cost of works to date.....	\$349,334 95
X. Bonded debt at date.....	241,600 00
*Y. Value of sinking fund at this date.....	114,100 00
Z. Rate of interest, 4 and 6 per cent.	

CONSUMPTION.

1. Estimated total population at date, 16,000.
2. " " " on lines of pipe, 14,200.
3. " " " supplied, 13,700.
4. Total number gallons consumed for year, 254,360,275.
5. Passed through domestic meters, 28,253,200 gallons, or 11.1 per cent.
6. Passed through manufacturing meters 12,953,250 gallons, or 5.3 per cent.
7. Average daily consumption, 696,877 gallons.
8. Gallons per day to each inhabitant, 45.
9. " " " " consumer, 50.
10. " " " " tap, 286.

DISTRIBUTION.

MAIN.

SERVICES.

- | | |
|---|--|
| 1. Kind of pipe, cement lined, cast iron, wrought iron. | 16. Galvanized iron, lead. |
| 2. Size, from $\frac{1}{2}$ inch to 10 inches. | 17. From $\frac{1}{2}$ inch to 4 inches. |
| 3. Extended 6,887 feet. | 18. 3,046 feet. |
| 4. Discontinued, 3,714 feet. | 19. 116 feet. |
| 5. Total now in use, 30.09 miles. | 20. 13.5 miles. |
| 6. Cost of repairs per mile, \$10.38. | 21. Service taps added, 105. |
| 7. Leaks per mile .3. | 22. Number now in use, 2,433. |
| 8. Small distribution pipe less than 4 inches, total length, 27,697 feet. | 23. Average length of service, 31.1. |
| 9. Hydrants added, 1. | 24. " cost " " \$11.09. |
| 10. Number now in use, 163. | 25. Meters added, 71. |
| 11. Stop gates added, 3. | 26. Number now in use, 445. |
| 12. Number now in use, 266. | a. domestic, 409. |
| 13. Small stop gates less than 4 inches, total 67. | b. manufacturing, 36. |
| 14. Number of blow-off gates, 5. | 27. Motors and elevators added, 1. |
| 15. Range of pressure on mains, at centre, for day and night, 70 to 85 lbs. | 28. Number now in use, 8. |

STORAGE.

Earthwork reservoirs, low service, capacity 6,236,000 gallons.
 Iron tank, high service, capacity 106,000 gallons.

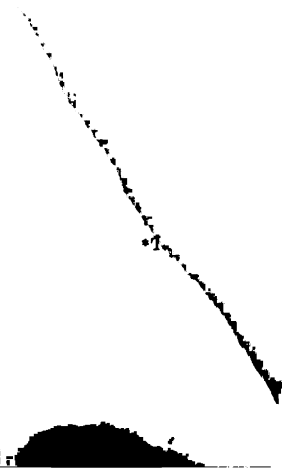
*Toward paying bonded debt of city of \$426,500.00.

TWENTY-THIRD
ANNUAL REPORT
OF THE
Water Department

OF THE
City of Burlington, Vt.,

DECEMBER 31st, 1889.

R. S. STYLES, BOOK AND JOB PRINTER,
107 ST. PAUL STREET, BURLINGTON, VT.
1890.



TWENTY-THIRD
ANNUAL REPORT

OF THE

Water Department

OF THE

CITY OF BURLINGTON, VT.,

DECEMBER 31st, 1889.



BURLINGTON :

R. S. STYLES, BOOK AND JOB PRINTER,
1890.

CITY OF BURLINGTON, VT.,
WATER DEPARTMENT.

1889.

WATER COMMISSIONERS.

Chairman, F. H. PARKER,
A. H. PARKER,
J. W. GOODELL.

SUPERINTENDENT.

F. H. CRANDALL.

COLLECTOR.

G. D. WELLER, *City Treasurer*.

PUMPING STATION.

JOEL W. THOMAS, *Engineer*.
ALFRED J. HOWARD, *Fireman*.

FOREMAN.

WILLIAM CASSIDY.

FIRST ANNUAL REPORT

OF THE

Water Commissioners.

To the Honorable Board of Aldermen :

GENTLEMEN :—The Board of Water Commissioners would respectfully make the following report, for the year ending December 31, 1889.

The affairs of the water department, which have heretofore been under the direction of a water committee from the board of Aldermen, have this season, in accordance with the amendment to the City Charter, passed by the last legislature, been directed by three Water Commissioners, of which number one member only retires each year.

The first meeting of the commissioners was held April 25th. F. H. Parker was elected chairman, and the superintendent, ex-officio, clerk of the board, and on April 29th F. H. Crandall was elected superintendent.

Regular meetings of the commissioners have been held on the Friday evening preceding the first Monday of each month, and special meetings have been held from time to time, and the work in progress frequently inspected.

We have been somewhat embarrassed in our labors, owing to the fact that while the amendment to the City Charter provides that "the water commissioners shall have the exclusive general management and control of the water works, subject to any limitations and restrictions contained in the ordinances," the original charter still provides, that "the City Council shall establish rates to be paid for the use of water, supplied by the city water works,

which shall be collected and enforced under such regulations as the City Council shall prescribe," and the reading of the ordinance in relation to the water department, still conforms to this section of the charter. If it is intended that the water commissioners shall have charge of the management of this department, it would seem proper, that the whole matter of rules and regulations, rates and collections should be entrusted to them, subject to the approval of the City Council, and we would recommend that the charter and ordinances be so amended.

RESERVOIRS.

The new reservoir has been in use since December, 1888, but was not completed until this season, and the experience gained from its use thus far, satisfies us that the old reservoir should be put in equally good repair without further delay. The excellent quality of our water the past summer, commended by all, was undoubtedly due to the cleanliness of the new reservoir, and yet, when the water was drawn off this fall, and the reservoir cleaned, there was found a surprisingly large quantity of sediment and vegetable growth on the slopes and bottom, showing the need of frequent and thorough cleaning. We do not think it is creditable to the city to maintain the old reservoir, either as a stagnant pond or mud hole, and considering the comparatively small expense of repairing this reservoir we think the city cannot afford to be without the additional fire protection that would then be afforded at all times, yet more particularly at times when one reservoir is being cleaned, or in case of an accident to the pumps. The fact that we have thus far been so fortunate as to never get entirely out of water at any time, is not a good reason to advance against supplying ourselves with ample storage. This new reservoir which is thought by some to be so much larger than our needs, was emptied by the street department once this summer without authority, by use of hydrants to clear some sewers filled with sand.

HYDRANT RENTAL.

We find that while the number of hydrants has been increased from year to year, the amount credited this department, \$1200 per year, has remained the same. There seems to be an impression prevalent with some, that this sum is intended to pay for water used by the fire department, and as we average comparatively few fires, that the sum is ample or perhaps excessive, while others state that as it is a mere matter of bookkeeping, charging the amount to one department, and crediting it to another, the custom might well be omitted. We find in other cities the allowance for hydrant rental varies greatly, being largest where the water works are owned by private corporations. The best authorities in New England estimate \$30 per hydrant, as a fair rate. The mere cost of keeping hydrants in repair, and pumping what water is used through them, does not ordinarily amount to a large sum, but in order to have an efficient fire service, requires much larger pipes, gates, specials and pumps, and adds very greatly to the cost of works, over what would be required to only supply water for domestic use. It is estimated that works built to afford fire protection cost three times as much as those built only for domestic supply.

It seems to us that no department should be asked to furnish something for nothing, but each should be entitled to proper credit for services rendered. It has and will require the expenditure of a large sum of money to afford this city fire protection, and the water department should receive proper credit for this investment, just as much as for collections from service and meter rates, and the same as would be received were the water works owned by a private corporation.

Our insurance rates are lower on account of the protection afforded, and in some cities this matter is properly viewed as a general insurance, and a special appropriation is made for hydrant service, entirely distinct from that for the fire department.

INVESTIGATIONS.

The systematic analysis of our water supply, started by your water committee last year, has been continued, and considerable time has also been given to investigating the possibility of obtaining a gravity supply. We know that our pumping expenses will increase as our population increases, and that to move the pumping station, or to lay a suction pipe to the broad lake, as has been agitated, would require a large expenditure and perpetual pumping expenses; therefore before advocating any of the above changes, we thought it would be well to make a careful examination, first of the quality and quantity of water that can be obtained within reasonable distance by gravity, and after becoming satisfied on those points, to estimate carefully the expense.

In 1866, when the matter of building our water works was under discussion, a gravity supply from Brown's River in Jericho was alluded to, and the matter was disposed of in the report in the following words: "at no distance less than about eleven miles can we obtain a supply of water by gravitation from any place, and as this would involve an expense of not less than \$500,000 such a mode of obtaining water at this time is out of the question." At that time iron pipe was high in cost, but in trying to save in distance in the above estimate, large pipe was required, as Jericho is but slightly above our reservoir. We have gone farther away in order to find water as free as possible from any probable chance of contamination, and with sufficient head to permit the use of smaller pipe, and yet at such a distance that the interest on the cost of such a change of supply, would not probably exceed the future pumping expenses. For the result of these investigations, we refer you to the annexed reports.

FIRE SERVICES.

Having ascertained that a large amount of water was being used in several instances through services that had been put in for fire service only, and from which the department received no revenue for water, the custom adopted in Boston, Fall River, and

other cities of sealing the valves on such services, to prevent their use only in case of fire, was adopted in October, and there has been a falling off in the amount of water pumped the last two months compared with the same time last year, of 7,000,000 gallons.

WATER DEPARTMENT OFFICE.

Frequent complaints have been made to us, because the superintendent's office is not open at all times during business hours, but so long as the collections are made by the City Treasurer, there is practically no work for a clerk in the superintendent's office, hence the office is closed most of the time, while he is attending to outside duties. It seems to us that the business of the water department, including collections, should be transacted in one office. The interests involved are large, and should be managed in a way not only to secure the largest return, but also in a way to serve the public most acceptably. We believe this can not be accomplished, when the responsibilities of the management are divided between two offices, and we therefore earnestly recommend that suitable quarters be provided for the water department, that may be kept open during business hours, and where information can be obtained, urgent wants secure prompt attention, and all business with the department be transacted, and we think if this is done the public will commend the change.

The department are under great obligations to Prof. W. W. Cook and Mr. J. L. Hills of the State Agricultural Experiment Station, for the time and labor given, and the interest taken in our investigations, and trust Mr. Hills' report will receive careful consideration.

The accompanying annual report of the superintendent is referred to for information in regard to the regular work of the department.

Respectfully submitted,

F. H. PARKER.	} <i>Water</i>
A. H. PARKER.	
J. W. GOODELL.	

Commissioners.

TWENTY-THIRD ANNUAL REPORT OF THE Superintendent of Water Works.

To the Honorable Board of Water Commissioners of the City of Burlington :

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works, for the year ending December 31st, 1889.

AVAILABLE FUNDS FOR THE USE OF THE WATER DEPT.

Appropriation.....	\$18,000.00
Sales of pipe, meters, etc.,.....	1,767.66— \$19,767.66

RECEIPTS.

From G. D. Weller, City Treasurer.....	\$19,119.50
Unexpended balance.....	\$648.16

DISBURSEMENTS—CONSTRUCTION.

Service Pipe and fittings.....	\$286.60
Labor on Services.....	293 10
Cast iron pipe, packing and lead.....	787.04
Labor on mains.....	376.67
Hydrants.....	30.00
Gates and supply pipes.....	43.00
Gate and cut off boxes.....	160.00
	\$1,976.41

WATER DEPARTMENT.

9

CURRENT

Pay rolls	\$1,226.41	
Materials for management and repairs	368.61	
Office expenses	141.85	
Printing, advertising and postage	31.55	
Superintendent	1,000.00	
Horse keeping, shoeing and repairs	375.90	
Gate and cut-off boxes	149.62	
Repair of hydrants	72.63	
Repair of tools	22.33	
Hydrants	90.00	
Replacing cement pipe with cast iron pipe	2,871.18	
Labor	1,925.00	
Packing, lead & stops	500.00	
Gates	360.10	
		<u>\$9,135.18</u>

PUMPING.

Pay rolls	\$1,940.50	
Supplies	150.66	
Fuel	3,109.03	
Repairs on machinery	193.34	
Repairs on buildings and grounds	323.68	
Rent of ground	300.00	
Repairs on motor	273.97	
Incidentals	37.22	
		<u>\$6,328.40</u>

METERS.

Meters	\$1,567.13	
Repairs and freight	112.38	
		<u>\$1,679.51</u>

RECAPITULATION.

Construction	\$1,976.41	
Current	9,135.18	
Pumping	6,328.40	
Meters	1,679.51	
		<u>\$19,119.50</u>

RESERVOIRS.

When early in the season, after having visited the grounds and agreed with the Commissioners as to the necessity of the work by them recommended, the majority of the Board of Aldermen, upon further consideration, deemed it inexpedient, at that time, to devote ten thousand dollars to the much needed repair of the old reservoir, the Commissioners at once decided to expend as little money as possible on work of a temporary nature. How successfully their plan has been carried out, the following statement will show :—

The new reservoir, complete, with all incidentals, has cost \$22,944.90. The repairs of the old reservoir have cost \$1,022.83, of which amount \$842.49 may be said to have been expended on permanent work, leaving only \$280.34 sunk in temporary make-shifts. About \$300.00 worth of pipe laid through the old reservoir was not charged to that account, as when the repairs are resumed it can be used elsewhere. The department has on hand about \$200.00 worth of pipes and castings procured in the spring of 1888, to lay from the gate house through the embankment of the old reservoir. From the foregoing it will be seen that of the \$25,000.00 appropriated for reservoirs in the spring of 1888, there remains \$1,032.27 unexpended at the completion of the work.

The following is a statement of the disbursements for the past year of the special appropriation made for reservoirs :

RECEIPTS.

From G. D. Weller, City Treasurer..... \$2,840.18

DISBURSEMENTS—NEW RESERVOIR.

Contractor, balance for contract work.....	\$1,293.72	
Blind drains, labor and materials.....	195.56	
Repairs on line fences.....	111.68	
Painting fences.....	81.66	
Wire fence around reservoir.....	371.67	
Rent of pasture adjoining reservoir lot, for two years.....	120.00	
		<hr/> \$2,174.29

OLD RESERVOIR.

Pipes and castings	\$ 52.49	
Labor in placing same	77.53	
Replacing iron steps	50.32	
W. H. Lang, Goodhue & Co., contract price for raising and strengthening the banks of the old reseryoir	485.55	
		<hr/> \$665.89
		<hr/> \$2,840.18

We hereby certify that we have examined the vouchers and accounts of the Superintendent of City Water Works, from January 1st to December 31st, 1889, and find the same correct.

MICAH H. STONE, }
H. R. WING, } *Auditors.*
W. C. ISHAM, }

WATER PUMPED.

1889.	Gallons.
January	18,784,125
February	18,723,125
March	18,697,225
April	19,037,125
May	23,103,400
June	23,521,550
July	24,437,475
August	24,638,350
September	23,295,000
October	24,792,400
November	18,357,950
December	19,270,475
Total water pumped in 1889	257,558,200
Total water pumped in 1888	254,360,275
Increase in 1889	3,197,925
Average daily consumption in 1889	705,639
Average daily consumption in 1888	696,877

SERVICES.

There have been added 82 services of the following sizes :

1	4 inch pipe.
1	1½ " "
1	1 " "
8	¾ " "
71	½ " "

Two services have been discontinued.

MAINS.

New mains have been laid on the following streets :

WITH FOUR INCH CAST IRON PIPE.

Canfield street easterly from Bissell street.....	84 feet
Loomis street easterly from Prospect street.....	408 "
Converse Court northerly from Hickok street.....	240 "
Buell street extended westerly	564 "
North Willard street extended northerly	161 "

WITH TWO INCH GALVANIZED IRON PIPE.

Converse Court, extending northerly.....	221 feet
Total length of new mains.....	1678 feet

The cement pipe in the following streets has been replaced this season :

WITH TEN INCH CAST IRON PIPE.

North street from Front street to Winooski Avenue...	2360 feet
--	-----------

WITH SIX INCH CAST IRON PIPE.

Front street from North street to Battery Place.....	864 feet
Total length of cement pipe replaced.....	3224 feet

LENGTH OF PIPE NOW IN USE.

Cement	90,579 feet
Iron	69,996 "
Total feet of pipe.....	160,575 feet
Total miles of pipe.....	30.41 miles.

HYDRANTS.

There have been six hydrants set this season.

LOCATION.	KIND.
Corner Blodgett and Strong streets	Lang Post
“ North and Front streets	“
“ North and Elmwood Avenue	“
“ South Willard and Maple streets	“
“ North Willard street and Archibald street	“
“ South Willard street at Cliff street	“

With the exception of the next to the last named, the above replace underground hydrants.

Total number of public hydrants 144

Total number of private hydrants 20

Total 164

GATES.

The following old gates on cement pipe have been removed.

Front street at Battery Place	1	4 inch
North Avenue at Battery Place	1	4 “
Battery street at North street	1	4 “
Champlain street at North street	1	4 “
Rose street at North street	1	4 “
Murray street at North street	1	3 “
Lafountain street at North street	1	4 “
North street at Battery street	1	4 “
North street at Elmwood Avenue	2	3 “

Total removed 10

The following gates have been set this season.

North at east line of Front	1	10 inch
“ at west line of Battery	1	10 “
“ at east line of Battery	1	10 “
“ at east line of Champlain	1	10 “

GATES—CONTINUED.

North at west line of Elmwood Avenue.....	1	10 inch
“ at east line of Elmwood Avenue.....	1	10 “
“ at west line of Winooski Avenue.....	1	10 “
Elmwood Avenue at north line of North.....	1	10 “
Battery at south line of North.....	1	10 “
Battery at north line of North.....	1	8 “
Elmwood Avenue at south line of North.....	1	6 “
Murray at south line of North.....	1	6 “
Front at south line of North.....	1	6 “
Front at north line of Battery Place.....	1	6 “
North Avenue at north line of Battery Place.....	1	4 “
Pitkin at north line of North.....	1	4 “
Champlain at north line of North.....	1	4 “
Rose at north line of North.....	1	4 “
Lafountain at north line of North.....	1	4 “

Total added..... 19

Total number of gates now in use..... 275

The repairs for the year have been :

On cement pipe.....	7 breaks
“ “	2 leaks
“ “	1 pick hole
On Iron pipe.....	2 breaks
“ “	1 split pipe
“ “	4 joint leaks
“ “	4 plug leaks
On service pipes	9 leaks
On broken hydrants.....	8
On broken gates.....	1

123 iron stop boxes and 18 iron gate boxes have been set to replace old wooden ones.

METERS.

There are now in use 525 meters, an increase of 80 over last year.

Of the water pumped 16% has been used through meters, yielding 45% of the collections.

The greater part of the season's work in pipe laying was done on North street where a three inch cement pipe, extending from Front street to Winoski Avenue, a distance of 2,360 feet, was replaced by a ten inch iron pipe. The length of cement pipe replaced represents a little less than one-half the length of ditch dug, as the services and intersecting mains transferred to the ten inch pipe swell the total length of ditch to 4,935 feet, but 245 feet less than a mile. This new main, properly gated, and connected with all the intersecting streets, more effectually maintains the pressure, and affords that portion of the city facilities for coping with a large fire which it has not heretofore possessed.

OTHER SOURCES OF SUPPLY.

In the fall of 1888 the attention of the Water Department was drawn, by the unusual amount of sickness in our city, to the condition as to purity of our source of supply. Examinations were made of the condition of the lake water at different points, and estimates made of the cost of various plans for the extension of the suction pipe. An examination of the bottom of the bay and broad lake, showed it to be of black mud, rich in organic matter. Just what proportion of which was animal organism and what proportion of those in turn were injurious, the examination did not determine; but so far as the bottom may be regarded as an index to the condition of the water above it, the indications were strong, that a short distance from the mouth of the sewer, there was little or no choice in the condition of the water. The bottom at, and near the pumping station, was found to be comparatively free from mud and organic matter. In the absence of any positive evidence of benefit to be derived from the

change, as also of any absolute assurance that the change would not be for the worse, it was deemed advisable to make no move at that time, but to institute a systematic investigation of all the available sources of water supply for the city. While the ice was on the lake, and it could in consequence be easily done, data were obtained for making accurate estimates on the extension of the suction pipe. At about the same time, and for the same reason, a survey of Hinesburg Pond was made, and its storage capacity ascertained. Careful environmental examination has been made of all the possible sources of supply within a radius of thirty miles, and samples for chemical analysis, taken from all that were not obviously, from lack of elevation or other cause, ineligible for a position on our list of available sources of gravity supply. Monthly analyses have been made at the State Agricultural Experiment Station, of water from nine different sources. A statement from Mr. J. L. Hills, station chemist, as to the work done, and deductions therefrom, will be incorporated in this report. The past season could hardly have been less favorable for determining the quantity of water which a stream might be relied upon to supply, and one season's work under any circumstances would hardly be sufficient to base an opinion upon. Some work, however, has been done and some information gained upon the subject.

It was intended that a single biological examination should be made of each of the locations under investigation, but the work progressed only far enough to convince the biologist that "It is better to bear the ills we have, than fly to those we know not of," when sickness and press of business necessitated its abandonment. Chemists, bacteriologists, and biologists are coming to recognize their mutual dependence, and in these days it will hardly do to pin one's faith to a single analyses, or to chemical analyses alone, yet while chemistry cannot teach everything, and cannot decide, it may teach considerable, and aid in the decision. The tables appended, giving the results of a se-

ries of examinations of lake, river, pond and spring waters in our immediate vicinity, as also the table giving the analyses of a number of city supplies, made by the National Board of Health, afford a subject for careful thought and study, as well as a chance for interesting comparisons, the results of which can scarcely be other than satisfactory to the consumers of Burlington water.

ARTESIAN WELLS.

There is little, if any, more accurate information to be had on this subject than when the report of the water committee was made in 1885. What we do know of the age and character of the rock through which boring would have to be made, indicates that water, if found, would not rise higher than the lake level. The geologists consulted agree that the finding of a supply which would flow into our reservoir would be the result of a peculiar combination of circumstances extremely unlikely to occur.

GRAVITY SUPPLIES.

HINESBURGH POND.

The supply of this pond, situated some 13 miles distant from and 300 feet above our reservoir, in a basin composed principally of black mud with a small portion of gravel bottom and rocky shore, is mostly drainage from surrounding country, and is not equal to the demands we should wish to provide for. In consequence, the pond would have to be used as a storage reservoir, for which its capacity is more than ample. The work, however, which would be necessary to make of it a suitable storage basin, would raise the cost fully up to that of procuring water from a much greater distance.

STARKSBORO SPRINGS.

The supply at Starksboro consists of five large and several more small springs issuing from the side of a gravel terrace about 100 feet in height, lying across the valley just east of the village of Starksboro, some 325 feet above and 21 miles distant from our reservoir. Mead's Brook, a part of which has been turned from its course around the terrace, and brought through it by means of a deep ditch, affords a means of reinforcing the springs which has in time past been used to increase the water power just east of the village.

LEE RIVER.

Lee River, at the Bolton road, about 450 feet above and 18 miles distant from our reservoir, derives its supply from an almost entirely uncultivated district in the notch, from which the Shepard & Morse mill has recently been removed, and from which all the merchantable timber has been cleared. The Lee receives several tributaries below this point, and flows into Brown's River below the mills at Jericho.

MILL BROOK.

Mill brook at a sufficient elevation for our purpose places us in a difficult and expensive locality through which to conduct a pipe line, besides in all probability being an expensive stream to divert from its present uses.

BROWN'S RIVER.

Brown's river, at the point from which samples for analysis were taken, just above Terrill's mill, is about 500 feet above and 19 miles distant from the reservoir. Its supply is derived from a drainage area consisting of, for the most part, uncultivated mountain slopes, of which the notch up which the ascent to Mt. Mansfield from this side is made, forms a part.

HUNTINGTON RIVER.

Huntington river, at a sufficient elevation for our purpose, is too far distant to be thought of.

COLCHESTER POND.

Colchester pond is not high enough to be available as a gravity supply.

Our pumping expenses, which have in the past, and must in the future increase with our population, and the extension of our sewage system, are already upwards of \$6.000.00 per annum. The extension of the suction to Marks' bay, or the broad lake, together with the cost of increasing our pumping capacity, would require an investment the interest on which would materially increase them. It would seem that before entering into any extensive improvements entailing a perpetual pumping expense, it would be well to obtain accurate information as to the cost and quality of the best gravity supply to be had.

All of which is respectfully submitted.

F. H. CRANDALL,

Superintendent.

SUMMARY OF STATISTICS.

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.
 Burlington, Chittenden County, Vermont.
 Population by city census, 1885, 13,357.
 Works constructed, 1867-8.
 Owned by city.
 Source of supply, Lake Champlain.
 Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery. . . . H. R. Worthington.
2. Description of fuel. $\left\{ \begin{array}{l} a \text{ Anthracite.} \\ c \text{ Grate.} \\ d \text{ Pittston.} \\ e \text{ \$4.75.} \\ g \text{ Mill shavings, \$38.50 per week, 28 weeks.} \end{array} \right\} 24 \text{ weeks.}$
6. Total pumpage for the year, 257,558,200 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
Cost of pumping figured on pumping station expenses,
\$6,328.40.
11. Per million gallons raised against dynamic head into reservoir, \$24.57
12. Per million gallons raised one foot high (dynamic), \$0.0777.

Cost of pumping figured on total maintenance.

\$26,655.58.

13. Per million gallons raised against dynamic head into reservoir, \$103.49.
14. Per million gallons raised one foot high (dynamic), \$0.327.

FINANCIAL.

Division I.

Receipts.		Maintenance.	Disbursements.	
From Consumers:			A.A. Management and repairs.....	
A. Water rates, domestic.....		\$28,629 22	BB. Interest on Bonds.....	
B. Water rates, manufacturing.....		2,400 00	CC. Total maintenance for year.....	
C. Net receipts for water.....		\$31,029 22	DD. Balance to the City Treasury.....	
E. Total.....				
From Public Funds:				
F. Hydrants.....	\$1,300 00			
G. Fountains and Parks.....	75 00			
H. Watering Troughs.....	250 00			
I. Public Buildings.....	75 00			
		\$1,600 00		
K. Gross receipts, all sources.....		\$32,629 22	EE. Total.....	

Division II.

From fixed rates	{	L. Domestic.....	\$15,235.70
		M. Manufacturing.....	100.00
		N.....	\$16,335.70
From meter rates	{	O. Domestic.....	\$12,393.52
		P. Manufacturing.....	2,300.00
		Q.....	\$14,693.52
Total.....			\$31,029.22

CONSTRUCTION.

T. Appropriation from tax levy.....	\$3,048 93	FF. Extension mains.....	\$1,276 41
U. Pipe and labor.....	1,787 66	GG. Extension service.....	700 00
V. Total.....	\$4,816 59	HH. Reservoir.....	2,940 18
		KK. Total.....	\$4,816 59
W. Cost of works to date.....			\$354,151.54
X. Bonded debt at date.....			215,000.00
Y. Value of sinking fund at this date.....			111,600.00
Z. Rate of interest, 4, 5 and 6%.....			

CONSUMPTION

1. Estimated total population at date, 16,000
2. " " " on lines of pipe, 14,200.
3. " " " supplied, 13,700.
4. Total number gallons consumed for year, 257,558,200.
5. Passed through domestic meters, 28,331,402 gallons, or 11 per cent.
6. Passed through manufacturing meters 12,877,910 gallons, or 5 per cent.
7. Average daily consumption, 705,639 gallons.
8. Gallons per day to each inhabitant, 44.
9. " " " " " consumer, 50.
10. " " " " " tap, 281.

DISTRIBUTION.

MAIN.

SERVICES.

- | | |
|--|--|
| 1. Kind of pipe, cement lined, cast iron, wrought iron. | 16. Galvanized iron, lead. |
| 2. Size, from $\frac{1}{4}$ inch to 10 inches. | 17. From $\frac{1}{4}$ inch to 4 inches. |
| 3. Extended 4,902 feet. | 18. 2,588 feet. |
| 4. Discontinued, 3,224 feet. | 19. 100 feet. |
| 5. Total now in use, 30.41 miles. | 20. 13.96 miles. |
| 6. Cost of repairs per mile, \$7.89. | 21. Service taps added, 82. |
| 7. Leaks per mile, .7. | 22. Number now in use, 2,513. |
| 8. Small distribution pipe less than 4 inches, total length, 25,829 feet. | 23. Average length of service, 81 ft. |
| | 24. " cost " \$7.80. |
| | 25. Meters added, 80. |
| 9. Hydrants added, 1. | 26. Number now in use, 525. |
| 10. Number now in use, 164. | a. domestic, 486. |
| 11. Stop gates added, 9. | b. manufacturing, 39. |
| 12. Number now in use, 275. | |
| 13. Small stop gates less than 4 inches, total, 67. | 27. Motors and elevators added, 2. |
| | 28. Number now in use, 10. |
| 14. Number of blow-off gates, 5. | |
| 15. Range of pressure on mains, at centre, for day and night, 70 to 85 pounds. | |

STORAGE.

Earthwork reservoirs, low service, capacity 6,236,000 gallons.

Iron tank, high service, capacity 106,000 gallons.

REPORT OF CHEMICAL WORK

Done at the State Agricultural Experiment Station.

To the Board of Water Commissioners, Burlington, Vt.:

GENTLEMEN :—Pursuant to request from your Board, the State Agricultural Experiment Station has made a series of chemical examinations of waters from various sources, during the months from May to November inclusive, of the current year. These analyses have been made monthly, on samples from each of the following supplies :—

Lake Champlain, at Marks Bay, (Red Rocks.)

" " Broad Lake.

" " at Pumping station.

" " service supply, Expt. Station laboratory.

Brown's River, above Terrill's Mill, Underhill, Vt.

Lee River, at Bolton cross roads, Jericho, Vt.

Starksboro Springs, at source, Starksboro, Vt.

Mead's Brook, at Starksboro Springs, Starksboro, Vt.

Hinesburg Pond, Hinesburg, Vt.

The samples were taken by the Superintendent of the Water Works, in bottles received from the Station, and in such careful and prescribed manner, as is guarantee for their correctness and authenticity, as representative of the various supplies at the dates of sampling. The following tabulations give the results obtained by Station analyses, together with collated data from other sources.

MONTHLY ANALYSES OF SAMPLES FROM LAKE CHAMPLAIN. — Parts per million.

TABLE A 1889.	MARKS' BAY.			BROAD LAKE.			PUMPING STA'N. SERVICE SUPPLY.		
	Free Ammonia	Albuminoid Ammonia	Chlorine	Free Ammonia	Albuminoid Ammonia	Chlorine	Free Ammonia	Albuminoid Ammonia	Chlorine
May	0.015	0.075	5.1	0.035	0.045	5.0	0.025	0.09	3.6
June	0.03	0.14	4.7	0.015	0.115	2.1	0.035	0.115	2.6
July	0.01	0.145	2.0	0.01	0.12	2.1	0.035	0.125	1.7
August	0.005	0.26	2.8	0.005	0.14	2.4	0.005	0.125	2.9
September	0.02	0.145	2.9	0.025	0.14	3.2	0.015	0.12	2.9
October	0.015	0.115	2.5	0.005	0.135	2.9	0.01	0.085	3.2
November	0.01	0.12	2.5	.....	.....	.....	0.01	0.115	2.1

MONTHLY ANALYSES OF SAMPLES FROM OTHER SOURCES. — Parts per million.

TABLE A 1889.	BROWN'S RIVER.			LEE RIVER.			STARKEBRO SPRINGS.			MEAD'S BROOK.			HINESBURG POND.		
	Free Ammonia	Albuminoid Ammonia	Chlorine	Free Ammonia	Albuminoid Ammonia	Chlorine	Free Ammonia	Albuminoid Ammonia	Chlorine	Free Ammonia	Albuminoid Ammonia	Chlorine	Free Ammonia	Albuminoid Ammonia	Chlorine
May	0.01	0.085	2.1	.....	.....	.....	0.02	0.03	7.4	.....	.....	.....	0.16	0.17	2.9
June	0.025	0.22	2.6	0.05	0.165	3.3	0.015	0.085	3.0	.....	.....	.....	0.05	0.18	3.0
July	0.02	0.14	2.9	0.065	0.15	2.6	0.01	0.08	3.6	.....	.....	.....	0.02	0.16	2.1
August	0.015	0.115	2.1	0.025	0.12	2.1	0.02	0.065	3.8	0.025	0.07	2.4	0.04	0.17	2.8
September	0.005	0.125	2.1	0.01	0.11	2.5	0.00	0.03	3.6	0.005	0.06	2.6	0.025	0.16	2.6
October . . . . .	.....	.....	.....	0.02	0.08	2.1	0.005	0.02	3.6	0.02	0.09	3.8	0.05	0.16	2.9
November	0.015	0.075	2.1	0.01	0.07	2.5	0.01	0.04	2.5	0.01	0.06	2.1	0.015	0.12	2.1

Determinations of total, fixed and volatile solids, oxygen consumed by organic matter, etc. were made on each source of supply once during the year, and upon the river, springs and pond supplies, the former estimations were made two or more times. These are shown in Table C.

TABLE

B

AVERAGE ANALYSES.

FROM MAY TO NOVEMBER, 1889,

Inclusive.

	PARTS PER MILLION.						
	Free Ammonia	Albuminoid Ammonia	Oxygen Consumed by Organic Matter.	Total Solids.	Fixed Solids.	Volatile Solids.	Chlorine
Brown's River, <i>Underhill</i>	0.015	0.127	4.05	60.2	30.0	42.4	2.8
Lee River, <i>Bolton</i>	0.08	0.116	4.28	53.8	19.0	34.8	2.5
Starksboro Springs, <i>Starksboro</i>	0.012	0.049	0.50	69.2	35.2	34.0	3.9
Mead's Brook,.....	0.015	0.075	1.98	58.7	34.3	24.4	2.6
Hinesburg Pond, <i>Hinesburg</i>	0.051	0.16	4.18	87.1	57.5	29.6	2.6
Lake Champlain, <i>Marke' Bay</i>	0.015	0.143	3.62	77.6	50.0	27.6	3.8
" " <i>Broad Lake</i>	0.016	0.116	3.57	75.0	44.0	31.0	3.0
" " <i>Pumping Station</i>	0.019	0.111	3.00	67.6	42.6	25.0	2.7
" " <i>Service Supply</i>	0.018	0.135	2.88	.....	.....	.....	.6

NOTE.—As free and albuminoid ammonia, and chlorine were the only determinations that were made each month, the figures under those columns only are average.

WATER DEPARTMENT.

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COLLATED ANALYSES PREVIOUS TO THE PRESENT INVESTIGATION. —Parts per million.

TABLE C.	SOURCE OF SAMPLE.	DATE.	ANALYSIS BY	H ₂ O	Alb	Total Solids	Fixed Solids	Volatiles	Chlorine
Hydrant.	1882	Mallet	0.085	0.14	70	20.	50	0.7
Service Supply, Elmwood Avenue	Sept., 1884	Sabin	0.04	0.18	164	.....	.....	.....
Mouth of Suction Pipe, Pumping Station	"	Sabin	0.16	0.16	86	.....	.....	2.1
"	"	"	Withaus	0.063	0.18	72	.....	.....	1.1
"	"	March, 1885	Withaus	0.084	0.10	89	.....	.....	0.2
"	"	"	W. R. Nichols	0.03	0.15	71	57.	14	.....
"	"	"	Seeley	.....	.....	60	41.	19	.....
"	"	Jan. 8, 1889	Hills	0.03	0.18	88.5	54.5	84	1.7
Northwest corner of Breakwater, 10 feet deep	Sept., 1884	Sabin	0.06	0.114	119	.....	.....	.....
"	"	"	Withaus	0.028	0.11	84	.....	.....	1.5
"	"	March, 1885	Withaus	0.016	0.08	75	.....	.....	1.1
"	"	"	W. R. Nichols	trace	0.06	73	60.	13	2.0
Foot of Bank Street.	Jan. 8, 1889	Hills	0.02	0.19	86	49.	37	1.4
Northwest corner of Breakwater, 26	Sept., 1884	Withaus	0.146	0.17	79	.....	.....	1.8
"	"	March, 1885	Withaus	0.084	0.08	76	.....	.....	1.0
"	"	"	W. R. Nichols	trace	0.08	70	55.	15	1.8
Marks' Bay, 53 feet deep	Sept., 1884	Sabin	0.048	0.10	107	.....	.....	.....
"	"	"	Withaus	0.06	0.10	56	.....	.....	5.8
"	"	March, 1885	Withaus	0.034	0.05	66	.....	.....	0.9
Surface, midway Sewer mouth to S. end Breakwater	Jan. 8, 1889	Hills	0.03	0.16	80	45.	35	2.9
"	"	Sept., 1884	Sabin	0.04	0.072	100	.....	.....	.....
"	"	"	Withaus	0.03	0.13	116	.....	.....	9.7
Three thousand feet west of Pumping Station	March, 1885	Seeley	.....	.....	69	52.	17	.....
Rock Point.	"	Seeley	.....	.....	61	44.	17	.....
Reservoir Water, 48 hours pumped	Sept., 1884	Sabin	0.093	0.168	129	.....	.....	.....
Reservoir Water, (Old Reservoir)	Dec. 29, 1888	Hills	0.03	0.16	80	45.	35	2.9
Reservoir Water, (New Reservoir)	"	Hills	0.03	0.18	88.5	54.5	84	4.3
"	"	Feb. 12, 1889	Hills	0.04	0.14	.....	.....	.....	2.4
Hinesburg Pond	March, 1885	W. R. Nichols	0.06	0.20	63	50.	13	2.6
"	"	"	Seeley	.....	.....	53	38.	20	.....
"	"	Feb. 13, 1889	Hills	0.04	0.15	93	43.	50	3.7

ANALYSES OF WATER SUPPLIES OF OTHER CITIES.

TABLE D SOURCE OF SUPPLY.	CITY SUPPLY OF	PARTS PER MILLION.							
		Free Ammonia.	Albuminoid Ammonia	Oxygen Consumed by Organic Matter	Total Solids	Fixed Solids	Volatile Solids	Blackening on Ignition.	Chlorine
Artesian Wells.....	Charleston, S. C.....	0.40	0.12	2.42	1150	1067	83	Slight	115.
Cochituate Lake.....	Boston.....	0.07	0.255	7.44	60	50	10	Decided	3.6
Croton River.....	New York.....	0.02	0.15	3.43	90	70	20	"	0.67
Jones Falls and Lake Roland	Baltimore.....	0.01	0.11	1.33	110	75	35	Medium	2.53
Schuylkill River.....	Philadelphia.....	0.105	0.21	2.14	130	100	30	"	6.0
Potomac River.....	Washington.....	0.05	0.127	1.02	165	75	95	Decided	1.1
James River.....	Richmond, Va.....	0.055	0.15	1.65	105	85	20	Slight	1.17
Mississippi River.....	New Orleans.....	0.055	0.29	4.90	320	265	55	Decided	14.4
Lake Michigan.....	Chicago.....	0.095	0.09	1.50	160	100	60	"	20.
Lake Champlain.....	Burlington, Vt.....	0.035	0.14	1.53	70	20	50	"	0.7
Mississippi River.....	Rock Island, Ill.....	0.01	0.045	none	140	45	95	Faint	46.6
Hudson River.....	Poughkeepsie, N. Y.....	0.05	0.125	2.29	85	45	40	Decided	4.5
Crosswick's Creek.....	Bordentown, N. J.....	0.085	0.175	2.72	80	35	45	"	2.33
Well Waters.....	Titusville, Pa.....	0.04	0.085	none	155	100	55	Slight	2.5
Oil Creek.....	".....	0.075	0.15	3.75	100	50	50	Decided	0.75
Easton's Pond.....	Newport, R. I.....	0.06	0.63	4.55	120	40	80	"	22.5

The demands upon the time of the Station Chemists in other directions, have not admitted of full and complete analyses of each sample each month, nor has it been considered necessary for the purposes of the present investigation.

A few words explanatory of the meaning of the terms used, and the significance of the data presented in the tabulations, may prove of use.

Generally speaking, excessive amounts of *free ammonia* and (or) *chlorine*, are indicative of contamination of an animal origin, usually sewage. *Albuminoid ammonia* is regarded as an indication of pollution from either or both animal and vegetable sources, the discrimination being made in accordance with free ammonia and chlorine results. An excessive amount of albuminoid ammonia, accompanied by large quantities of free ammonia, owes its origin to animal contamination, but if in excess, and unaccompanied by any marked amount of free ammonia, the source of pollution is regarded to be of a vegetable and, usually less noxious nature. Further and more detailed explanation of these terms has already been published in the "Report of the Water Committee of the City of Burlington, Vt., upon the City Water Supply, &c.," (Feb. 1886,) pages 19, 24. and 32, hence more lengthy and specific remarks on this point are not essential at the present time.

The maximum limits of ingredients, directly or indirectly noxious, permissible in drinking water, have been established as follows, viz :

0.05 parts free ammonia per million.

0.15 parts alb. " " "

70. parts chlorine " "

These limits are more or less elastic, and should not be considered as absolute expressions of fact. The interpretation of the meaning of a greater or less amount of these noxious ingredients, is to be materially modified by the testimony of environmental survey. Chlorine in excessive amounts in inland surface

waters is indicative of sewage contamination, but the quantity of this ingredient found in waters near the ocean or from saline deposits, is no guide whatever in estimating ammonia pollution. These very ingredients occur abundantly in nature in innocuous forms, and although their presence in the average water is in a noxious form, or in such form as furnishes food for lower organism, such as disease germs, &c., they often are present in waters from artesian wells, peat swamps, &c., in vast amounts, under circumstances precluding possibility of contamination. On the other hand, disease germs may be present without large accompanying amounts of free and albuminoid ammonia, and the water afford no evidence of danger to the chemist. The biologist can in such cases materially aid the chemist. It is to more effectually cover such cases, that the custom of late years has come into vogue to lay little or no stress on the results of isolated chemical analyses, but to control the quality of city water supplies by the threefold guard of environmental survey, chemical analysis and microscopical research, conducted at regular and stated (usually monthly) intervals. Correct deductions cannot always be drawn from the testimony of the chemical analysis of a water, without understanding the physical surroundings of the supply. It has been said with entire truth, by one of the foremost American investigators in the chemistry of water supplies: "In judging the sanitary character of a water, not only must such (chemical) processes be used in connection with the investigation of other evidence of a more general sort, as to the source and history of the water, but should even be deemed of secondary importance in weighing reasons for accepting or rejecting a water not manifestly unfit for drinking on other grounds." Mallet,—National Board Health Report, 1882.

Notwithstanding the acknowledged limitations of chemical analysis as applied to the investigation of water supplies, such regular inspection as the Experiment Station has carried out on the sources under discussion, has much value.

Referring to table B, it will be noted that the average analysis of no supply exceeds limits in any ingredient, except that of Hinesburg Pond, in free and albuminoid ammonia. An exceptionally and unaccountably high free ammonia contents in the May sample from this source, makes an average amount of free ammonia probably in excess of truth. Regarded from the standpoint of purity alone, the two Starksboro supplies rank first, followed by a group of the four lake and two river supplies, which are about upon a par, while the Hinesburg Pond supply proves less pure than any other. It will be noted that exclusive of the six Hinesburg samples, which almost without exception exceed the limit slightly, but five out of forty-nine analyses exceed the limit, two of which five are but slightly in excess. The testimony of chemical analysis would appear to be, so far as one year's experience can indicate, that all the source supplies are of medium purity, except possibly that from Hinesburg Pond. The waters from the rivers, brooks and springs possess at least one pronounced advantage over the lake supply. There is less likelihood of contamination, such as may escape the chemist's attention, in mountain streams flowing from a sparsely settled district, than in the lake water into which our city sewage pours. The Station chemists have not been able to detect evidences of sewage in samples from Marks' Bay or the Pumping station (or indeed in a series of samples taken about one hundred yards away from the sewer mouth, in the endeavor to trace the direction of sewage currents), but the constant possibility of sewage contamination remains, and though these mountain supplies may at times show an amount of organic matter equal to or exceeding in amount that found in the lake water, the character of such organic matter would be liable to be less noxious.

There does not appear to be great difference between the waters from the pumping station and from Marks' Bay, such as there is, being in favor of the former locality. One very bad sample—Marks' Bay—August, which not im-

probably owed its contamination to sewage, raises the average amount of albuminoid ammonia from that source, making it, perhaps a little higher than truth. One of the most interesting points brought out by a study of the results in tables A and B, is that the water from the "Broad Lake" does not appear purer than that taken inshore. This result was not anticipated. The character of the bottom of the broad lake seems to be, if anything, more muddy than that inside the breakwater. A series of samples of the lake bottom, twenty-three in number, were taken, ranging along inside the breakwater from the sewer mouth, north, and then at a right angle beyond the north end of the breakwater out into the "Broad Lake." It was endeavored to determine if sewage deposits or other detritus was more marked inside than outside the breakwater. Had a clean bottom of sand or clay been found outside and a foul one within, the presumption would have been that the character of the water would be more or less affected by such a difference. The results of this line of investigation were indeterminate, but sufficiently comparative to warrant the assertion that no essential difference exists in the nature of the lake bottom, as regards mud, etc., apart from points near the sewer, inside or outside the breakwater. Indeed the lake bottom around the present inlet pipe is cleaner than at any of the other places examined. Judging by the results afforded by the series of samples taken this year from the Broad Lake and from what is known regarding the currents of the Winooski River, and the occasional excursions of our sewage current into the Broad Lake, it does not appear settled that the extension of the suction pipe will of necessity, give our community a purer water supply.

The writer has collated such analyses of the sources under discussion as he has found, for purposes of comparison, which study indicates that the quality of the lake water does not appear to have appreciably changed within the past few years. In table D he has gathered a series of analyses from the work of the chem-

ists of the National Board of Health, showing the grade of supplies of several cities of the country. These are all the analyses of public supplies there given without exception. A comparison of free and albuminoid ammonia and chlorine results, as there given, with those afforded by analyses of our present supply, will indicate that, while the character of Lake Champlain water is not irreproachable, yet we are as well supplied as are fully three-quarters of the cities there cited.

Respectfully submitted.

JOSEPH L. HILLS,

Chemist, Experiment Station.

STATE AGRICULTURAL EXPERIMENT STATION.

BURLINGTON, VERMONT, DEC. 31, 1889.

TWENTY-FOURTH
ANNUAL REPORT
—OF THE—
WATER DEPARTMENT
—OF THE—
CITY OF BURLINGTON, VT.,
DECEMBER 31,
1890.

BURLINGTON :
THE FREE PRESS ASSOCIATION.
1891.

..... 1 . \$

REFERENCE LIBRARY.

Metropolitan Water Board.

ENGINEERING DEPARTMENT.

Room..... Bookcase.....

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This book belongs to the Engineering Department of the Metropolitan Water Board, Boston, Mass.

Persons using this book must take due care thereof and return it without delay to the bookcase after using.

None of the books to be taken from the Engineering Department without the permission of the Chief Engineer, and receipt given therefor.

All persons will be required to observe the above regulations.

By order of the Chief Engineer.

TWENTY-FOURTH

ANNUAL REPORT

—OF THE—

WATER DEPARTMENT

—OF THE—

CITY OF BURLINGTON, VT.,

DECEMBER 31,

1890.

BURLINGTON :
THE FREE PRESS ASSOCIATION.
1891.

CITY OF BURLINGTON, VT.,

WATER DEPARTMENT.

1890.

WATER COMMISSIONERS,

Chairman, F. H. PARKER,
A. H. PARKER,
J. W. GOODELL.

SUPERINTENDENT,

F. H. CRANDALL.

COLLECTOR,

G. D. WELLER, *City Treasurer*.

PUMPING STATION,

JOEL W. THOMAS, *Engineer*.
ALFRED J. HOWARD, *Fireman*.

FOREMAN,

WILLIAM CASSIDY.

REPORT
OF THE
Water Commissioners.

To the Honorable Board of Aldermen:

Gentlemen—The Board of Water Commissioners would respectfully make the following report for the year ending December 31, 1890 :

The receipts of the department for the year have been, from city taxes, \$18,500 ; from sale of pipe, meters, etc, \$1,253.61 ; a total of \$19,753.61, and the expenditures, \$19,649.80, leaving an unexpended balance of \$103.81. There was also received an appropriation of 10% on the grand list, amounting to \$10,417 for the repair of the old reservoir and increasing the height of the high service tank and building. Of this amount there has been disbursed \$8,370.75 ; the balance, \$3,078.52, includes the 20% of contract price, which is withheld until the completion of the work, and is ample for the purpose. The reservoirs together have a capacity of 7,000,000 gallons, are now in daily use, can be used or cleaned independently of each other, and are a credit to the city. The Superintendent reports the daily average pumping for the first seventeen days of August as 1,100,000 gallons, while the capacity of the pumps is but 1,500,000 gallons per day. This experience would seem to settle the fact that our reservoir capacity is not too great.

The Treasurer reports the water collections for the year \$33,289 79, an increase over the previous year of \$660 57.

The question is quite frequently asked, do our Water Works pay running expenses? We would answer that from tables re-

cently made up in this office, we find the works first paid running expenses and interest on the bonds in 1879, and with the exception of three years, have continued to pay ever since. The excess of surplus over deficiency for the twelve years amounts to a little over \$26,000.00.

In the above computation no account is taken of coal or material on hand each year, as it is assumed that the average amount on hand is practically the same, when extended over a series of years. Nor is the construction account included, as the amount expended in increasing the plant is not part of the yearly expense of running the works, but the amount expended annually in replacing cement pipe is charged to current expense, and is therefore included.

All investigations in regard to obtaining a gravity supply have been discontinued, as it was ascertained that in dry summers like the last, the amount of water available from any one of the supplies, while ample for the present was not deemed equal to our prospective needs, without the building of a large storage reservoir at the source of supply. This would not only increase the expense largely but would provide much less desirable water.

Lake Champlain seems destined to be our future supply, but from what point and in what manner we shall obtain it demands very careful consideration.

We would express our appreciation of the more commodious and convenient quarters now being provided for this department and request your favorable consideration of the other recommendations made in our last report.

The report of the superintendent will furnish detailed information in regard to the season's work.

Respectfully submitted,

F. H. PARKER,	} <i>Water</i>	
A. H. PARKER,		} <i>Commissioners.</i>
J. W. GOODELL,		

TWENTY-FOURTH ANNUAL REPORT
OF THE
Superintendent of Water Works.

To the Honorable Board of Water Commissioners of the City of Burlington:

Gentlemen—The following is a statement of the receipts and disbursements of the Burlington City Water Works, for the year ending December 31, 1890:

AVAILABLE FUNDS FOR THE USE OF THE WATER
DEPARTMENT.

Appropriation.....	\$18,500 00
Sales of pipe, meters, etc.....	1,253 61
	\$19,753 61

RECEIPTS,

From G. D. Weller, City Treasurer.....	\$19,649 80
Unexpended balance	\$ 103 81

DISBURSEMENTS—CONSTRUCTION.

Service pipe and fittings.....	\$303 24
Labor on services.....	104 00
Cast iron pipe, packing and lead.....	459 55
Labor on mains.....	97 69
Hydrants.....	90 00
Gates.....	200 00
Gate and cut-off boxes.....	142 26
	\$ 1,396 74

CURRENT.

13	Pay rolls.....	\$2,452 60	2 804.73
11	Material for management and repairs.....	526 13	860.61
8	Office expenses.....	324 10	310.01
2	Printing, advertising and postage.....	56 05	34.72
12	F. H. Crandall, Superintendent, salary one year.....	1,000 00	1000 ✓
	Chemical and biological examinations of the lake and other supplies.....	64 40	89.78 ✓
4	Repairs on higher service tank.....	82 32	
1	J. W. Beatty, damages.....	55 00	10. ✓
5	F. H. Parker, Commissioner, salary one year.....	100 00	100. ✓
	A. H. Parker, Commissioner, salary four months.....	16 67	
	J. W. Goodell, Commissioner, salary four months.....	8 33	
1	Horse keeping, shoeing and repairs.....	469 02	367.47 ✓
16	Gate and cut-off boxes.....	529 50	503.60 ✓
6	Repair of hydrants.....	168 47	107.94 ✓
3	Repair of tools.....	30 81	47.35 ✓
1	Hydrants.....	375 00	197.03 ✓
1	Incidentals.....	18 00	1319.23
	Replacing cement pipe with cast iron pipe.....	2,935 01	1941.37
	Labor.....	383 75	2493.90
	Packing and lead.....	567 01	341.43
	Gates.....	244 31	183.20
			\$10,406 48

PUMPING.

Pay rolls.....	\$1,970 96
Supplies.....	170 22
Fuel.....	2,979 59
Repairs on machinery.....	471 34

WATER DEPARTMENT.

9

Repairs on buildings and grounds.....	76 57	
Rent of ground.....	200 00	
Repairs on motor.....	143 04	
		<hr/>
		\$6,011 72

METERS.

Meters.....	\$1,793 15	
Repairs and freight.....	41 71	
		<hr/>
		\$1,834 86

RECAPITULATION.

Construction.....	\$ 1,396 74	
Current	10,406 48	
Pumping	6,011 72	
Meters.....	1,834 86	
		<hr/>
		\$19,649 80

RESERVOIR AND TANK REPAIRS.

FUNDS AVAILABLE.

Amount of the 10% of the grand list for 1890, appropriated by the board of Al- dermen, thus far by the treasurer credited to account.....	\$10,417 00	
Balance from former appropriation.....	1,032 27	
		<hr/>
		\$11,449 27

RECEIPTS.

Received from City Treasurer.....	\$8,370 75	
		<hr/>
Unexpended balance.....	\$3,078 52	

DISBURSEMENTS.

Contractor, on account of reservoir reps...	\$7,274 55	
Contractor, on account of tank reps.	1,000 00	
Material for six inch waste.....	48 00	
Pay rolls.....	48 20	
		<hr/>
		\$8,370 75

We hereby certify that we have examined the vouchers and accounts of the Superintendent of City Water Works, from January 1st to December 31st, 1890, and find the same correct.

MICAH H. STONE, }
H. R. WING, } *Auditors.*
W. C. ISHAM, }

WATER PUMPED.

1890.	Gallons.
January	19,162,525
February	18,425,475
March	20,914,525
April	19,438,250
May	22,840,400
June	25,425,725
July	29,146,825
August	30,435,175
September	22,843,175
October	24,336,425
November	22,757,275
December	23,645,575
Total, 1890 ¹⁸⁹¹	279,371,350
Total, 1889 ¹⁸⁹¹	257,558,200
Increase in 1890 ¹⁸⁹¹	21,813,150
Daily average in 1890 ¹⁸⁹¹	705,637
Daily average in 1890 ¹⁸⁹¹	756,401

SERVICES.

There have been added thirty-eight services of the following sizes:

One	3 inch.
Two	1 "
Thirty-five	$\frac{1}{2}$ "

Two services have been discontinued.

MAINS.

A new four-inch iron main has been laid in Russell street, extending northerly from North street.... 440 feet
 The cement pipe in North street, between Front street and North ave., has been replaced with ten inch cast iron pipe a distance of..... 420 feet

SUPPLY PIPE.

A two inch galvanized iron supply pipe has been laid in Voltz street extending westerly from North Bend 244 feet

LENGTH OF PIPE NOW IN USE.

Cement.....	90,159 feet
Iron.....	70,856 "

Total feet of pipe.....	161,015 feet
" miles of pipe.....	30.41 miles.

HYDRANTS.

Five hydrants have been set this season.

LOCATION.	KIND.
Corner South Union and Bay View streets.....	Lang Post
" St. Paul and Maple streets	" "
" Battery " King "	" "
" Lafountain and Cedar streets.....	" "
Colchester ave. near hospital.....	" "

With the exception of the first named, the above replace other hydrants. One hydrant, the underground, at the corner of Church and Bank streets has been discontinued.

Total number of public hydrants.....	144
" " private "	20
Total.....	164

The hydrants have as usual been twice thoroughly inspected and repaired, once during the summer and again late in the fall.

GATES.

The following old gates have been removed :

Battery at College street.....	1	10 inch
College " Battery street.....	1	10 "
Cedar " Elmwood ave	1	4 "
Blodgett " North street.....	1	4 "
North " Front street.....	1	4 "
North " North ave.....	1	4 "
Winooski ave. at College street.....	1	4 "
" " Grant "	1	4 "

Total removed.....8

The following gates have been set this season :

North street at North ave.....	1	10 inch
Battery " College street.....	1	10 "
College " Battery street.....	1	10 "
North ave. at North street.....	1	6 "
Pearl street at Williams street.....	1	6 "
North Lumber yard near Crane's office.....	1	6 "
Pearl street at Williams street.....	1	4 "
Cedar street at Elmwood ave.....	1	4 "
Blodgett street at North street.....	1	4 "
Winooski ave. at College street.....	1	4 "
North ave. at North street.....	1	4 "

Total added.....11

Total number of gates now in use.....278

The repairs for the year have been :

On cement pipe.....	10 breaks.
On iron pipe.....	2 split pipes.
" "	3 joint leaks.

On service pipes	11 leaks.
On broken hydrants	18 "
On broken gates	4 "

240 iron stop boxes and 50 iron gate boxes have been set during the season to replace old wooden ones, wherever change of grade or other causes have rendered it necessary. Though there have been many more stop boxes than usual replaced this year there is still ample opportunity for the continuance of the work another season.

METERS.

There are now in use 584 meters, an increase of 59 over last year. Besides the 59 meters set in new locations, there have been 34 new meters set to replace old ones.

Of the 584 meters, now in use, 317 are owned by the consumers, and 267 are the property of the city. Experience has demonstrated that it is more satisfactory, both to the consumer and the water department, to have the meters owned by the latter, and under the present management this result is gradually being accomplished. The amount paid to the manufacturers this year for meter repairs has been quite small, not that no repairs have been made, for the constantly increasing number of meters and increasing age of those in the service creates each year a greater demand for time and attention, but that the effort to keep worn out meters of the old pattern in repair has been abandoned, and the other repairs have, for the most part, been effected here, and the expense in consequence appear on the current pay rolls.

The pumpage for the year, it will be seen, is considerably in excess of former years. The daily average for the first seventeen days in August was slightly in excess of 1,100,000 gallons within 400,000 gallons of the full capacity of our pumps. Of the water pumped 17% has been used through meters, yielding 46% of the collection.

THE SEASON'S WORK.

At the opening of the season, advantage was taken of the opportunity afforded, while the western division of the horse railroad was blockaded, during the construction of the North street sewer, to replace the cement pipe remaining in North street between the 10-inch iron pipe, laid last season, and North avenue. This piece of work, owing in part to the nature of the soil, but more to the fact that the earth had been loosened by the sewer ditch the year previous, occupied considerable time. Bracing, however carefully used, cannot be made to entirely prevent caving, and is productive of annoying delay in the handling of cast iron pipe.

With the exception of the case of East avenue, where the demands were too great for the supply, all the applications for extension of mains have been granted.

A short piece of cement pipe, north of W. & D. G. Crane's mill, has been replaced with iron pipe, with a gate, by pass, and pressure regulating valve, by means of which the needs of the Standard Oil Co., the only consumers on the long line of light cement pipe in the north yard, are supplied, and the weak pipe relieved of the heavy pressure which for years it has been declaring its inability to stand. Since the above repairs were effected there have been no breaks reported from the north yard, which, considering the fact that heretofore about one-half of all the breaks occurring on cement pipe happened on that line, is a very noticeable as well as gratifying alteration of circumstances.

The dead end on Pearl street, at Williams street, has been abolished, and a much needed feeder thus afforded the north part of the town.

New gates have been set and old ones repaired in several localities, which will enable repairs to be made with much less annoyance to consumers on account of shutting off than heretofore. For obvious reasons, other than those of convenience, it

should not be necessary to shut off large sections for repairs. Considerable work of this kind might still be done to advantage.

Owing to the large amount of work, in the line of general repairs, demanding attention, the department was unable to lay all of the cast iron pipe procured for the purpose of replacing cement, and has now on hand 1,200 feet of 10-inch, a portion of which was taken out of the old reservoir, and 2,000 feet of 6-inch, with the necessary lead, yarn and specials.

RESERVOIR REPAIRS.

As soon as there were funds available for the repairs of the old reservoir, work was begun to ascertain the amount of labor it would be necessary to bestow upon the banks. When the slopes and bottom were cleared of the cobble paving and sand which covered them, it was found that they could not be improved with the material at hand. This decision considerably reduced the probable expense of the work, and when, with the better prices of this year, Messrs. Lang, Goodhue & Co., in the light of the information gained during the preparatory work, revised their former proposition, it was found that all of the contemplated work could probably be done with the funds at hand, and early in August a contract was entered into with Lang, Goodhue & Co., for the full completion, in every particular, of such repair of the old reservoir as would place it in as good and satisfactory condition as the new one adjoining it, the consideration being \$9,093 19, of which amount eighty per cent. has, according to agreement, been paid the contracting firm.

The work was sufficiently advanced to admit of cleaning the new reservoir in October last, and though as yet not finished it is in a condition to be used this winter, and will require but a few weeks' work in the spring to entirely complete it. The other part of the work contemplated in the appropriation of last June, the raising of the higher service tank, has been repeatedly de-

layed, at first by the failure to receive the iron, and more recently by the conditions of temperature at this, the coldest point in the city. The roof and brick walls of the building were raised the required height early in the season.

That this difficult and dangerous undertaking was accomplished, without injury or accident, was largely owing to the good management and care of that veteran handler of the jacks, Mr. Jack Hathaway.

The capacity of the tank will be increased 63,617 gallons, or sixty per cent., by the contemplated increase of twelve feet in its height. The cost of the improvement will be \$1,400.00, of which \$1,000.00 has already been paid for work done, and the balance will soon become due on the completion of the tank.

OTHER SOURCES OF SUPPLY.

Since our last report all the sources, which had otherwise been considered available for a gravity supply, have been carefully tested by Weir measurement for quantity, and in no case has there been found a sufficient supply to meet our needs without the use of a storage reservoir. The effect of such a reservoir, however suitably constructed and arranged for the purpose of impounding and carrying in its original purity such supply through the continuous natural changes of its life, among unnatural surroundings, is liable to be very unsatisfactory. The examinations thus far made show that no improvement in quality or lessening of expense, but rather the reverse is to be expected as the result of a change from our present system, and investigation in this line has in consequence been abandoned.

All of which is respectfully submitted,

F. H. CRANDALL,

Superintendent.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water works.
 Burlington, Chittenden County, Vermont.
 Population by U. S. census, 1890, 14,590.
 Works constructed, 1867-8.
 Owned by city.
 Source of supply, Lake Champlain.
 Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery....H. R. Worthington.
2. Description $\left\{ \begin{array}{l} a \text{ Anthracite.} \\ c \text{ Grate.} \\ d \text{ Pittston.} \\ e \text{ \$4 85.} \\ g \text{ Mill shavings,} \end{array} \right\} \begin{array}{l} \\ \\ 30 \text{ weeks.} \\ \\ \$36 \text{ 00 per week,} \\ 22 \text{ weeks.} \end{array}$
 of fuel.
6. Total pumpage for the year, 279,371,350 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
 Cost of pumping figured on pumping station expenses,
 \$6,011 72.
11. Per million gallons raised against dynamic head into reservoir, \$21 52.
12. Per million gallons raised one foot high (dynamic), \$0.0681



TWENTY-FIFTH

ANNUAL REPORT

—OF THE—

WATER DEPARTMENT

—OF THE—

CITY OF BURLINGTON, VT.,

DECEMBER 31,

1891.

BURLINGTON :

THE FREE PRESS ASSOCIATION,
PRINTERS, PUBLISHERS AND BOOKBINDERS.
1892.

LIBRARY
OF THE
Boston Society of Civil Engineers.

No. 3655

Received Jan 1899

PRESENTED BY

E. B. Weston.

RULES.

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Members may borrow books for home use, but no one shall have more than four books at any time, nor keep any book more than five weeks.

A member borrowing a book shall give a receipt therefor to a member of the Library Committee, to the Secretary, or to the regular attendant.

A fine of one cent per day per volume shall be charged for overtime, and must be paid before the delinquent can take any more books.

Current numbers or unbound files of periodicals shall not be taken from the room.

Books of unusual value are marked with a star (*), and must not be taken from the room, except by written permission from the Board of Government.

Any person mutilating or losing a book shall pay for the damage, or replace the book.

Any one who violates the above rules shall, upon written request from the Librarian to the Board of Government, be debarred from the privileges of the library for such time, not less than three months, as the Board of Government may determine.

(Adopted Nov. 18, 1896.)

3 1521 25

TWENTY-FIFTH

ANNUAL REPORT

—OF THE—

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CITY OF BURLINGTON, VT.,

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1892.

TWENTY-FIFTH ANNUAL REPORT

OF THE

Water Department,

Of the City of Burlington, Vt., December 31, 1891.

WATER COMMISSIONERS.

Chairman, F. H. PARKER,
A. H. PARKER,
J. W. GOODELL.

Superintendent, F. H. CRANDALL.

Collector, G. D. WELLER, City Treasurer.

Pumping Station, JOEL W. THOMAS, Engineer.
ALFRED HOWARD, Fireman.

WILLIAM CASSIDY, Foreman.

REPORT
OF THE
Water Commissioners.

To the Honorable the City Council:

GENTLEMEN :—The Board of Water Commissioners would respectfully make the following report for the year ending December 31, 1891.

The receipts for water reported by the City Treasurer have been \$35,589.19, an increase over the previous year of \$2,299.40. The report of the Superintendent herewith presented will give the necessary information of the detailed work of the year.

We note with satisfaction the increase in the number of meters, and the decrease in the amount of cement pipe in use.

Several cities are now supplying their water takers with meters, free of cost, finding compensation for such expenditure in reduced waste, which means fewer hours of pumping, less wear of pumps, and a less amount required for fuel and supplies. Were it not for our water meters we would undoubtedly be obliged to run our pumps night and day, and would probably receive considerable less revenue from the water sold. We think that the city should own all meters, and that it would be a good investment to meter every service where the service rates exceed ten dollars on premises where there is a sewer connection.

We would again suggest the advisability of having the water collections made in the office of the Superintendent. This work

has increased largely in the past few years, owing to the growth of the City, and the increase in the number of meter bills. It would seem to be good business policy, to consolidate all the business pertaining to the Water Department in one office, instead of having the responsibilities divided, and the work of making collections crowded into the office of the City Treasurer, where without it, there is an abundance of work. We do not advocate this change from any selfish motive, as it would add largely to the responsibilities of the Superintendent and Commissioners, but we consider that it would be beneficial to the Water Department, and more convenient for the public, and would be in line with the general policy of improvement that we are endeavoring to carry out.

Respectfully submitted,

F. H. PARKER,	} <i>Water</i>	
A. H. PARKER,		} <i>Commissioners.</i>
J. W. GOODELL,		

TWENTY-FIFTH ANNUAL REPORT
OF THE
Superintendent of Water Works.

To the Honorable Board of Water Commissioners of the City of Burlington:

GENTLEMEN:—The following is a statement of the receipts and disbursements of the Burlington City Water Works, for the year ending December thirty-first, 1891:

AVAILABLE FUNDS FOR THE USE OF THE WATER DEPARTMENT.

Balance from 1890.....	\$103 81	
Less bills paid by the City Treasurer.....	15 50	\$ 88 31
Sale of pipe, meters, etc.....		3,545 28
Appropriations		21,100 00
Total.....		<u>\$24,733 59</u>

RECEIPTS.

From G. D. Weller, City Treasurer.....	<u>\$24,479 91</u>
Unexpended balance.....	\$253 68

DISBURSEMENTS—CONSTRUCTION.

Gates.....	\$ 104 00
Gate and cut-off boxes.....	112 00
Service pipe and fittings.....	200 00

Labor on services.....	\$ 242 60
Labor on mains.....	1,358 29
Cast-iron pipe, packing and lead.....	2,000 01
	<hr/>
	\$ 4,016 90

CURRENT.

Pay rolls.....	\$ 2,804 73
Material purchased and used for and at the expense of others.....	1,319 23
F. H. Crandall, Superintendent, salary one year.....	1,000 00
Material for management and repairs	860 61
Gate and cut-off boxes.....	505 60
Horse keeping, shoeing, repairs, etc.....	367 57
Office expenses.....	310 01
Bills for labor.....	197 03
Repair of hydrants.....	107 95
F. H. Parker, Chairman of Board of Commissioners	100 00
Furniture for new office.....	89 78
Repair of tools.....	47 55
Printing, advertising and postage.....	34 75
George Bills, damages.....	10 00
Replacing cement pipe with cast iron pipe.....	1,941 37
Labor	2,593 90
Packing and lead	251 53
Gates.....	183 20
	<hr/>
	\$12,724 81

PUMPING.

Fuel.....	\$ 4,283 65
Pay rolls	1,978 75
Repairs to machinery	284 10
Supplies	114 13

WATER DEPARTMENT.

7

Insurance.....	\$ 100 00	
Repairs on buildings and grounds.....	89 00	
Rent of ground to September 1st, 1890, ..	33 33	
Repairs on motor	22 16	
	<u> </u>	\$ 6,905 12

METERS.

Meters.....	\$ 727 70	
Repairs and freight	105 38	
	<u> </u>	\$ 833 08

RECAPITULATION.

Construction	\$ 4,016 90	
Current.....	12,724 81	
Pumping	6,905 12	
Meters.....	833 08	
	<u> </u>	\$24,479 91

RESERVOIR AND TANK REPAIRS.**FUNDS AVAILABLE.**

Amount of the ten per cent on the grand
list of 1890, appropriated by the
Board of Aldermen for the work,
which was collected and apportioned
to the account in 1891.....

to the account in 1891.....	\$ 84 60	
Balance from 1890.....	3,078 52	
	<u> </u>	\$ 3,163 12

RECEIPTS.

From G. D. Weller, Treasurer	\$ 3,163 12
------------------------------------	-------------

DISBURSEMENTS—RESERVOIR REPAIRS.

Contractor, balance on account.....	\$ 2,174 89
Street department, crushed stone, cobble stone and time.....	41 55

Netting, posts, rails, base boards, wire and other material for fence around the old reservoir.....	\$ 143 65
Labor on fence, drains and paths	91 50
	<hr/> \$ 2,451 59

TANK REPAIRS.

Contractors, balance on account.....	\$ 400 00
Labor, drawing-off, drying, cleaning and painting	181 00
Coal, oil, paint and other material.....	72 90
Four inch waste, gate, pipe and man-hole	57 63
	<hr/> \$ 711 53
	<hr/> \$3,163 12

We hereby certify that we have examined the vouchers and accounts of the Superintendent of City Water Works, from January 1st, to December 31st, 1891, and find the same correct.

M. H. STONE,	} <i>Auditors.</i>
H. R. WING,	
W. C. ISHAM,	

WATER PUMPED.

1891.	Gallons.
January	24,839,025
February	21,345,950
March	24,642,450
April	20,609,225
May	23,932,825
June	30,060,750
July	32,720,025
August	24,427,425
September	26,575,700
October	23,859,225

1891.	Gallons.
November	23,528,375
December	21,959,600
Total, 1891	298,500,575
Total, 1890	279,371,350
Increase in 1891	19,129,225
Daily average in 1890	756,401
Daily average in 1891	817,809

SERVICES.

There have been added 61 services of the following sizes :

Three	6	inch.
Four	4	"
Three	1½	"
One	1½	"
One	1	"
Ten	¾	"
Thirty-nine	½	"

One of the above was to replace a discontinued service, and one was laid on Church street, during the progress of the work there, to avoid, if possible, future tearing up of the road-way.

SUPPLY PIPE.

A one and one-half inch galvanized iron pipe has been laid in Summer street, easterly from Front street..... 150 feet.

The supply pipe in the following streets has been replaced this season with 4 inch cast iron pipe :

School street, southerly from dead end	169	feet.
East avenue, northerly from dead end	45	"
Mechanics lane, easterly from Church street	40	"

Total length of supply pipe replaced

254	feet.
-----	-------

Total now in use

21,986	"
--------	---

MAINS.

New mains have been laid in the following streets:

WITH FOUR-INCH CAST IRON PIPE.

Spruce street, easterly from dead end.....	215 feet
School street, northerly from dead end.....	215 "
East avenue, southerly from dead end.....	575 "
South Union street, southerly from dead end....	72 "
Walnut street, southerly from dead end.....	192 "
Summit street, northerly from Maple. (High Service)	378 "

WITH SIX-INCH CAST IRON PIPE.

Park avenue, westerly from Shelburne street....	2,341 feet.
Briggs street, southerly from Park avenue.....	733 "

WITH TEN-INCH CAST IRON PIPE.

Shelburne street, northerly from Park avenue....	42 "
--	------

Total length of new mains..... 4,763 feet.

The cement pipe in the following streets has been replaced this season:

WITH FOUR-INCH CAST IRON PIPE.

King street, from St. Paul street to Pine street..	419 feet.
Laterals, from Winooski avenue and North street..	46 "

WITH SIX INCH CAST IRON PIPE.

King street, from Pine street to Battery street...	800 feet.
Winooski avenue, from North street northerly..	821 "
St. Paul street, from Main street to Maple street..	758 "
Church street, from Main street to College street	403 "
North lumber yard, from end of iron pipe, north- erly	668 "
Laterals, from North, King and College streets..	194 "

WITH EIGHT-INCH CAST IRON PIPE.

Willard street, at the head of Spruce street.....	65 feet.
---	----------

WITH TEN-INCH CAST IRON PIPE.

College street, from Union street easterly.....	433 feet.
---	-----------

North street, from Winooski avenue easterly....	1,213 "
---	---------

Total length of cement pipe replaced....	5,820 feet.
--	-------------

LENGTH OF PIPE NOW IN USE.

Cement.....	84,339 feet.
-------------	--------------

Iron.....	81,693 "
-----------	----------

Total feet of pipe.....	166,032 feet.
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Total miles of pipe.....	31.44
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HYDRANTS.

Six new Lang post hydrants, located as follows, have been added to the service during the past season:

Corner Williams and College streets.

" Champlain and Cedar streets.

" Willard and Spruce streets.

" North and School streets.

" Park avenue and Briggs street.

" Lyman avenue and Briggs street.

At the first two of the above named locations ground hydrants were replaced. In the course of the season's repairs six hydrants have been moved, but not sufficiently to change the description of their location. There have also been set four private hydrants, three on the premises of The Burlington Cotton Mills Co., Colchester avenue, and one on the premises occupied by Crane Brothers & Pope at the Lake.

Total number of public hydrants.....	148
--------------------------------------	-----

" " " private hydrants.....	24
-----------------------------	----

Total.....	172
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GATES.

The following old gates have been discontinued :

Pump house yard.....	1	10	inch.
College at South Union.....	1	10	"
North at Winooski avenue.....	2	3	"
Union at North.....	1	4	"
Church at College.....	1	4	"
Winooski avenue at Pearl.....	1	4	"
Hyde at North.....	1	3	"
King at St. Paul.....	1	3	"
King at Champlain.....	2	3	"
King at South Battery.....	1	3	"
Pump house yard.....	1	6	"
Total removed.....	13		

The following gates have been set this season :

North at east line of Winooski avenue.....	1	10	inch.
North at west line of North Union.....	1	10	"
North at east line of North Union.....	1	10	"
North at west line of School.....	1	10	"
North at west line of Russell.....	1	10	"
College at west line of South Union.....	1	10	"
College at east line of South Union.....	1	10	"
College at junction of iron and cement pipe.....	1	10	"
Pump house yard.....	1	10	"
South Willard at north line of Spruce.....	1	8	"
South Willard at south line of Spruce.....	1	8	"
North Winooski avenue at south line of North...	1	6	"
North Winooski avenue at north line of North...	1	6	"
North Winooski avenue at west line of Decatur...	1	6	"
North Winooski avenue at east line of Decatur...	1	6	"
St. Paul at south line of Main.....	1	6	"
St. Paul at north line of King.....	1	6	"
St. Paul at south line of King.....	1	6	"

St. Paul at north line of Maple.....	1	6 inch.
King at east line of Battery.....	1	6 "
King at west line of Champlain.....	1	6 "
King at east line of Champlain.....	1	6 "
King at west line of Pine.....	1	6 "
Champlain at north line of King.....	1	6 "
Champlain at south line of King.....	1	6 "
Church at north line of Main.....	1	6 "
Church at south line College.....	1	6 "
Park avenue at west line of Shelburne.....	1	6 "
Park avenue at east line of Pine.....	1	6 "
Park avenue at west line of Pine.....	1	6 "
Park avenue at east line of Briggs.....	1	6 inch.
Briggs at south line of Park avenue.....	1	6 "
Briggs at north line of Furguson avenue.....	1	6 "
Briggs at north line of Lyman avenue.....	1	6 "
Pump house yard.....	1	6 "
North lumber yard near blow-off at Crane's.....	2	6 "
Fire service for Crane Bros. & Pope at the lake....	1	6 "
Fire service for Burl. Cotton Mills Co. Colch. ave.	1	6 "
Fire service for Burl. Cotton Mills Co. Pine St....	1	6 "
Fire service for Burl. Woolen Co. Colchester avenue.....	1	6 "
Hyde at north line of North.....	1	4 "
School at south line of North.....	1	4 "
King at east line of Pine.....	1	4 "
King at west line of St. Paul.....	1	4 "
Spruce at west line of Willard.....	1	4 "
Summit at north line of Maple.....	1	4 "
Mechanics at east line of Church.....	1	4 "
Winoski avenue at south line of Grant.....	1	4 "
Winoski avenue at south line of Pearl.....	1	4 "
S. Willard at north line of College.....	1	4 "
Meter testing service at City Hall, Church St....	1	4 "

Hydrant branch, Burl. Cotton Mills Co. Chase St.	1	4	inch.
Hydrant branch cor. of North and School streets.	1	4	"
Blow-off at Crane's mill.....	1	4	"
Fire service for W. J. Van Patten, Main street....	1	4	"
Fire service for E. B. & A. C. Whiting, Pine street.	1	4	"
Fire service for Horatio Hickok, Pine street.....	1	4	"
Total added.....		60	
Total now in use.....			325

The repairs for the year have been:

On cement pipe.....	7	breaks.
On iron pipe.....	1	split pipe.
" ".....	2	plug leaks.
" ".....	1	joint leak.
On service pipe.....	9	leaks.
On broken hydrants.....	8	
On broken gates.....	1	

One-hundred and forty iron stop boxes and twelve iron gate boxes have been set to replace old wooden ones.

METERS.

There are now in use 654 meters, an increase of 70 over last year. Of this number, 324 are owned by the consumers, and 330 are the property of the city. Of the water pumped 19½% has been used through meters, yielding 46½% of the collections.

PUMPING.

The pumps are in good condition, and with the ordinary repairs, will remain so long after our consumption has grown to exceed the limit of their capacity. The yearly increase in length of our public sewers, together with our increase of population, furnishes a valid explanation of our constantly increasing pumpage, which is already, for a city of our population, largely in excess of the requirements of legitimate consumption, and would,

no doubt, by a more general use of meters, and more rigid inspection, be considerably reduced.

CURRENT.

The season has been a very favorable one for pipe laying, and owing to the large amount of pipe on hand at the beginning of the year, also to the unusual demand for extensions of the system and for fire services, there has been considerable of this work done. Besides the thirty-one hundred and sixteen feet of pipe laid at the Ferguson and Scarff addition, the mains about the city have been extended sixteen hundred and forty-seven feet, and six thousand two hundred and forty-four feet of new cast iron pipe has been laid to replace smaller cement, old aqueduct and galvanized iron pipes. In addition to the gates required on the somewhat over two miles of pipe laid, several have been set at locations where experience has shown them to be most needed, in most cases to replace old ones, and a four inch blow-off has been added to the system near Crane's mill. The Burbank property adjacent to the reservoir lot, purchased by the City Council for the purpose of enlarging the reservoir grounds, has been put in a suitable condition to answer the purpose for which it was placed in the hands of the Water Department. The old buildings, fences and underbrush, have been removed, a deep well stoned up, and the lot graded.

The work of reservoir and tank repairs finished during the past season was begun in 1888, when an appropriation of twenty-five thousand dollars was made for the purpose of building a new reservoir and repairing the old one. During the seasons of 1888 and 1889 the work of building the new reservoir and making such repairs as were absolutely necessary on the old one was accomplished. In 1890, for the better and more complete repair of the old reservoir, and for increasing the height and capacity of the high service tank, ten per-cent of the grand list was appropriated. Of this latter appropriation \$10,501.60 has been by

the Treasurer credited to the account. The funds \$35,501.60 thus made available for the work, have been expended as shown by detailed accounts in this and former reports, \$22,944.90 for construction of the new reservoir, \$10,845.17 for the repairs of the old reservoir, and \$1,711.53 for the repairs of the high service tank.

The addition to the high service was effected, and the tank cleaned and painted without interruption of supply to consumers, the motor or small pump, or both, as occasion required, supplying the needs.

The tank was filled the latter part of March, and has been in satisfactory operation since that time. The low service reservoirs have been used connectedly during the entire season, except such time as one or other of them were drawn off for cleaning.

The advantage of having two reservoirs has been well demonstrated, even at this early date. Besides the advantages for cleaning the reservoirs themselves, the increased storage capacity enables repairs to be made upon the pumps more easily, and in many ways contributes to the efficiency of the service.

The greater freedom than usual from fishy odor and taste, has also by many been attributed to having a clean storage basin.

All of which is respectfully submitted,

F. H. CRANDALL,

Superintendent.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association

Burlington City Water Works.
 Burlington, Chittenden County, Vermont.
 Population by U. S. census, 1890, 14, 590.
 Works constructed, 1867-8.
 Owned by city.
 Source of supply, Lake Champlain.
 Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel.

{	<i>a</i> Anthracite. <i>c</i> Grate. <i>d</i> Pittston. <i>e</i> \$4.85.	}	34 weeks.
---	---	---	-----------

g Mill shavings, \$36.00 per week, 18 weeks-
6. Total pumpage for the year, 298,500,575 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
Cost of pumping figured on pumping station expenses,
 \$ 6,905.12.
11. Per million gallons raised against dynamic head into reservoir, \$23.13.

12. Per million gallons raised one foot high (dynamic),
\$0.0732.

Cost of pumping figured on total maintenance,
\$31,318.53.

13. Per million gallons raised against dynamic head into
reservoir, \$104.92.
14. Per million gallons raised one foot high (dynamic),
\$.332.

FINANCIAL.

Division I.

MAINTENANCE.

Receipts.		Disbursements.	
From Consumers.		AA. Management and re-	
A. Water rates, domestic.	\$30,892 48	pairs.....	\$30,058 53
B. Water rates, manufac-		BB. Interest on Bonds.....	11,263 00
turing	8,096 77	CC. Total maintenance....	\$81,318 53
From public funds.		DD. Balance to the City	
C. Hydrants.....	\$1,200 01	Treasurer.....	7,815 94
D. Fountains and Parks....	75 00		
E. Watering Troughs.....	250 00		
F. Public Buildings.....	75 00		
	1,600 00		
G. Net receipts for water..	\$35,589 19		
H. Sale of pipes, meters, etc.	8,545 28		
I. Gross receipts.....	\$39,134 47	EE. Total.....	\$39,134 47

Division II.

From fixed rates.	{ L. Domestic.....	\$17,575 81
	{ M. Manufacturing.....	100 00
	N.....	\$17,675 81
From meter rates.	{ O. Domestic.....	\$14,916 61
	{ P. Manufacturing.....	2,996 77
	Q.....	17,913 38
Total.....		\$35,589 19

CONSTRUCTION.

Receipts.		Disbursements.	
T. Appropriation.....	\$8,980 02	FF. Extension of mains.....	\$3,499 80
		GG. Extension of services.....	517 60
		HH. Rebuilding Reservoir.....	2,451 59
		II. Reservoir lot.....	1,750 00
		JJ. Raising Tank.....	711 58
V. Total.....	\$8,980 02	KK. Total.....	\$8,980 02

W.	Cost of works to date.....	\$372,849 05
X.	Bonded debt at date.....	190,000 00
Y.	Value of sinking fund at this date.....	101,013 69
Z.	Rate of interest, four and five per cent.	

CONSUMPTION.

1. Estimated total population at date, 14,450.
2. " " " on lines of pipe, 14,450.
3. " " " supplied, 14,150.
4. Total number of gallons consumed for year, 298,500,575.
5. Passed through domestic meters, 42,133,875 gallons, or 14.1 per cent.
6. Passed through manufacturing meters, 16,170,000 gallons, or 5.4 per cent.
7. Average daily consumption, 817,809 gallons.
8. Gallons per day to each inhabitant, 55.
9. " " " consumer, 58.
10. " " " tap, 314.

DISTRIBUTION.

MAIN.

SERVICES.

- | | |
|---|---|
| 1. Kind of pipe, cement lined, cast iron, wrought iron. | 16. Galvanized iron, lead. |
| 2. Size, from 4 to 16 inches. | 17. From $\frac{1}{2}$ to 6 inches. |
| 3. Extended, 10,837 feet. | 18. 1,554 feet. |
| 4. Discontinued, 6,074 feet. | 19. 74 feet. |
| 5. Total now in use, 31.44 miles. | 20. 14.41 miles. |
| 6. Cost of repairs per mile, \$3.20. | 21. Service taps added, 61. |
| 7. Leaks per mile, .35. | 22. Number now in use, 2,609. |
| 8. Small distribution pipe less than 4 inch, total length 21,986 feet. | 23. Average length of service, 29 feet. |
| 9. Hydrants added, 8. | 24. Average cost of service, \$3.15. |
| 10. Number now in use, 172. | 25. Meters added, 70. |
| 11. Stop gates added, 60. | 26. Number now in use, 654. |
| 12. Number now in use, 325. | a. domestic, 605. |
| 13. Small stop gates less than 4 inch, total, 70. | b. manufacturing, 49. |
| 14. Number of blow-off gates, 6. | 27. Motors and elevators added, 1. |
| 15. Range of pressure on mains at centre, for day and night, 70 to 85 pounds. | 28. Number now in use, 17. |

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons.
 Iron tank, high service, capacity 169,617 gallons.

TWENTY-SIXTH

ANNUAL REPORT

OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.

December 31,

1892.

BURLINGTON :
FREE PRESS ASSOCIATION,
PUBLISHERS, PRINTERS AND BOOKBINDERS,
1893.

TWENTY-SIXTH .
ANNUAL REPORT
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.
December 31,
1892.

With Compliments of

FRANK H. GRANDALL,

Please Exchange

SUPERINTENDENT.

FOURTH ANNUAL REPORT

OF THE

Water Commissioners.

To the Honorable the City Council, City of Burlington :

GENTLEMEN :--The Water Commissioners would respectfully present the following report for the year ending December 31st, 1892 :

The City Treasurer reports having received \$39,530.37 for water during the past year, an increase of \$3,941.18 over the receipts of 1891.

For the details of the work of the department we refer you to the report of the Superintendent herewith presented. We are pleased to note a slight decrease in the pumpage of the past year, indicating a corresponding decrease in the immense waste of water that is constantly made apparent to this board.

This waste, occasioned in some instances by the shallowness of the mains, but in most cases by exposed plumbing on private property, will, if it is allowed to continue, within a short time cause our consumption to exceed the capacity of our pumps.

We feel sure that your Honorable Board and our fellow citizens at large, will agree with us as to the advisability of

delaying as long as consistent, the expenditure requisite for new pumps, and will heartily co-operate with us in our efforts to check waste, by the extension of the meter system and gradual replacing of shallow mains.

We desire to express to your Honorable Body our hearty appreciation of your acts during the year, in the carrying out of former recommendations, and would respectfully again refer you to such as have not been acted upon.

We feel called upon to bring to your attention the situation of the present intake of our water supply, in connection with the plan recently adopted for carrying the sewage into the lake outside the docks, making thereby a possible danger of contamination of the water at our present source of supply.

It is important that the conditions now existing should not be made hazardous to the public health, and inasmuch as there seems to be no other practicable way than that adopted relative to the sewer outlet, the intake of our water supply should be extended *as soon as it can consistently be done* to such location in the lake as to prevent any possible danger.

Respectfully submitted,

J. W. GOODELL,	}	<i>Water Commissioners.</i>
A. H. PARKER,		
L. C. GRANT,		

TWENTY-SIXTH ANNUAL REPORT
OF THE
SUPERINTENDENT
OF
WATER WORKS.

*To the Honorable Board of Water Commissioners of the
City of Burlington :*

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31st, 1892 :

AVAILABLE FUNDS FOR THE USE OF THE WATER DEPARTMENT.

Balance from 1891	\$ 253 68
Sale of pipe, meters, etc.	899 75
Appropriations	18,750 00
Total	<u>\$19,903 43</u>

RECEIPTS.

From G. D. Weller, City Treasurer	<u>\$19,902 77</u>
Unexpended balance	\$0.66

DISBURSEMENTS.

CONSTRUCTION.

Gate and cut off boxes.....	\$ 40 00
Labor on services.....	236 40
Labor on mains.....	197 99
Cast iron pipe, packing and lead.....	543 50
Hydrants.....	90 00
	<hr/>
	\$1,107 89

CURRENT.

Pay rolls.....	\$2,674 14
F. H. Crandall, Superintendent, salary one year....	1,000 00
Material for management and repairs.....	547 66
Office expenses.....	373 38
Horse keeping, shoeing, repairs, etc.....	343 83
Prof. Sedgwick professional services, and other ex- penses attendant upon making a report with recommendations relative to the location of the intake.....	335 00
Material purchased and used for and at the expense of others.....	247 21
Repair of Hydrants.....	202 79
Bills for labor.....	138 45
Gate and cut-off boxes.....	131 40
Cleaning and painting high service tank.....	114 98
Freight and express charges.....	99 68
J. W. Goodell, chairman, salary.....	64 48
Hydrants.....	60 00
F. H. Parker, chairman, salary.....	35 52
Repair of Tools.....	33 30

Replacing Cement Pipe :

Pipe.....	2,683 79
Labor.....	1,432 70
Packing and lead.....	556 93
Gates.....	556 74
	<hr/>
	\$11,631 98

PUMPING.

Fuel.....	\$ 3,022 63
Pay rolls.....	2,008 49
Repairs to machinery.....	310 42
Supplies.....	156 66
Repairs to motor.....	89 14
Repairs to building and grounds.....	13 62
	<hr/>
	\$ 5,600 96

METERS.

Meters.....	\$ 912 10
Pay rolls.....	510 56
Material for management and repairs.....	139 28
	<hr/>
	\$ 1,561 94

RECAPITULATION.

Construction.....	\$ 1,107 89
Current.....	11,631 98
Pumping.....	5,600 96
Meters.....	1,561 94
	<hr/>
	\$19,902 77

We hereby certify that we have examined the vouchers and accounts of the Superintendent of City Water Works, from January 1st, to December 31st, 1892, and find the same correct.

M. H. STONE, }
 H. R. WING, } *Auditors.*
 W. C. ISHAM, }

WATER DEPARTMENT.

WATER PUMPED.

1892.	Gallons.
January	19,653,075
February	22,999,400
March	22,952,750
April	21,081,975
May	23,448,775
June	25,157,425
July	27,569,400
August	26,303,525
September	26,734,050
October	25,059,600
November	22,747,950
December	24,382,650
Total, 1892	288,090,575
Total, 1891	298,500,575
Decrease in 1892	11,410,000
Daily average in 1891	817,809
Daily average in 1892	789,289

SERVICES.

There have been added 57 services of the following sizes :

Two	4	inch.
One	3	"
One	2½	"
One	2	"
Two	1	"
Two	¾	"
Forty-eight	½	"

Two ½ inch services have been discontinued.

SUPPLY PIPE.

Two hundred and seventeen feet of half inch galvanized iron supply pipe in Maple street extending easterly from St. Paul street has been discontinued since the laying of a cast iron main in that street.

Total length now in use.....21,769 feet.

MAINS.

New mains have been laid in the following streets :

WITH FOUR-INCH CAST IRON PIPE.

Bay View street easterly from dead end..... 242 feet.

WITH SIX-INCH CAST IRON PIPE.

Maple street from St. Paul street to Church street.. 373 feet.

Total length on new mains..... 615 feet.

The cement pipe in the following streets has been replaced this season :

WITH FOUR-INCH CAST IRON PIPE.

Adams street from St. Paul street to Elm street... 776 feet.

WITH SIX-INCH CAST IRON PIPE.

Winooski avenue from College street to Bank street 395 feet.

Bank street from Winooski avenue to St. Paul street..... 760 "

Adams street from Elm street to Union street..... 470 "

WITH TEN-INCH CAST IRON PIPE.

Battery street from Battery Place to North street.. 882 feet.

Total length of cement pipe replaced..... 3,283 feet.

LENGTH OF PIPE NOW IN USE.

Cement.....	81,056 feet.
Iron.....	85,591 "

Total feet of pipe.....166,647 feet.

Total miles of pipe... 31.56

HYDRANTS.

Lang post hydrants located as follows have been set during the past season :

University Place at Billings Library.

" " South college.

Colchester avenue at Hospital.

Corner Prospect and Main streets.

" Mansfield avenue and Loomis street.

" Prospect and Pearl streets.

" Battery street and Smith's lane.

Colchester avenue at Chase street.

All the above replace other hydrants.

The first six are post hydrants with steamer nozzle, and in every case except that at the corner of Pearl and Prospect streets, where a ground hydrant was replaced, they replace post hydrants. The last two also replace ground hydrants. Four hydrants have been raised or lowered to suit the changes of grade.

Total number of public hydrants.....148

" " " private hydrants..... 24

Total.....172

GATES.

The following gates have been discontinued :

Crombie street at Winooski avenue.....	1	4	inch.
“ “ “ Interval avenue.....	1	4	“
Bank “ “ St. Paul street.....	1	4	“
Union “ “ Main street.....	1	4	“
Battery “ “ Battery Place.....	1	4	“
Smith's lane “ Battery street.....	1	4	“

Total.....	6		
------------	---	--	--

The following gates have been set this season :

Crombie street at west line of Winooski avenue....	1	4	inch.
“ “ “ east “ Interval avenue....	1	4	“
Union “ “ south “ Main street.....	1	4	“
Adams “ “ west “ Church street.....	1	4	“
“ “ “ east “ “ “	1	4	“
“ “ “ west “ Elm “	1	4	“
“ “ “ east “ “ “	1	4	“
Adams “ “ west “ Union “	1	6	“
Bank “ “ east “ St. Paul “	1	6	“
“ “ “ west “ Church “	1	6	“
“ “ “ east “ “ “	1	6	“
“ “ “ west “ Winooski avenue....	1	6	“
Winooski avenue at north line of Bank street.....	1	6	“
“ “ south “ “ “	1	6	“
Smith's lane at east line of Battery street.....	1	6	“
Maple street at east line of St. Paul street.....	1	6	“
“ “ west “ Church “	1	6	“
Main street west of Champlain street.....	1	10	“
Battery Place at west line of Battery street.....	1	10	“
Battery street at north line of Battery Place.....	1	10	“

Two gates have been set on fire services for Cham- plain Manufacturing Company.....	2 4 inch.
Total added.....	22
Total now in use.....	347

The repairs for the year have been:

On cement pipe.....	3 breaks.
“ “.....	8 leaks.
On iron pipe.....	4 joint leaks.
“ “.....	1 plug leak.
On service pipe.....	10 leaks.
On broken hydrants.....	17
On broken gates.....	3

The work of replacing wooden stop and gate boxes with iron, wherever necessary, has been continued during the past season. Thirty-four services have been lowered on account of change in grade.

METERS.

There are now in use 711 meters, an increase of 57 over last year. Of this number, 284 are owned by the consumers, and 422 are the property of the city. Of the water pumped 20 per cent has been used through meters, yielding 48 per cent of the collections.

PUMPING.

There has been, notwithstanding the increased number of services and increased facilities for waste afforded by the extension of the sewer system, a slight decrease in the amount of water pumped during the past year. That a decrease under the circumstances has been effected, is undoubtedly owing to

the growing favor in which the meter system is held and the consequent increase in their use. Thus far the department has set but very few meters, in almost every case the meter having been set at the request of the water taker. The pumps are in usual good repair, and if the increase in the use of meters and consequent restriction of waste continues, will be as adequate for our needs for some years to come, as they have been during the years just past.

All of which is respectfully submitted.

F. H. CRANDALL,
Superintendent.

TWENTY-SEVENTH

ANNUAL REPORT

OF THE

Water Department

OF THE

City of Burlington, Vt.,

December 31,

1893.

BURLINGTON :
P. C. DODGE, STEAM BOOK AND JOB PRINTER.
1894.

1 . \$

REFERENCE LIBRARY.

Metropolitan Water Board.

ENGINEERING DEPARTMENT.

Room..... Bookcase.....
Division..... Shelf.....
No.....

This book belongs to the Engineering Department of the Metropolitan Water Board, Boston, Mass.

Persons using this book must take due care thereof and return it without delay to the bookcase after using.

None of the books to be taken from the Engineering Department without the permission of the Chief Engineer, and receipt given therefor.

All persons will be required to observe the above regulations.

By order of the Chief Engineer.

TWENTY-SEVENTH

ANNUAL REPORT

OF THE

Water Department.

OF THE

City of Burlington, Vt.,

December 31,

1893.

BURLINGTON:
P. C. DODGE, STEAM BOOK AND JOB PRINTER.
1894

FIFTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable the Board of Aldermen, City of Burlington :

GENTLEMEN : In compliance with City Ordinance the Water Commissioners respectfully submit the following, their report for the year ending December 31st, 1893.

OFFICE.

The work of collecting for the water department, which was during his term of office faithfully and efficiently performed by our able ex-treasurer in the City Treasurer's office, was at the commencement of the year turned over to this office.

The rooms fitted up for the department in 1891 with this change in view, have proved convenient and suitable for the purpose. The advantages of having easily accessible quarters, where, at any time during business hours, information can be obtained, urgent wants receive prompt attention, and all business with the water department be transacted, are, we think, generally appreciated.

WATER RATES.

We are glad to note that the recommendations of this board, that fire protection be assessed in proportion to the value of property protected rather, than in proportion to quantity of water used, and that, for the encouragement of the use of meters, checking of waste and more equitable assessment of

water taxes, the rates be lowered to those paying the highest prices for metered water, have been acted upon by your honorable body. The effect of the two changes upon the annual collections has been about as was anticipated, the collections \$36,085.87 together with the unpaid rates, being \$1,202.52 in excess of the Mayor's estimates.

EXTENSIONS.

Preparations have been made for a start early in the season on the three extensions of the system for which money was provided by the citizens' meeting of July 5th, 1893. Mr. J. G. Falcon, the contractor for the intake extension, has been on the ground for some time getting things in readiness for a start in laying submerged pipe as soon as the ice goes out of the lake. The well and shore work will be done before that time, and it is expected that early in the season it will be possible to obtain the city's water supply from outside the harbor.

The conduit will be put together with flexible joints in lengths of seventy-two feet and after laying each length the work will be tested. For the North Avenue and Shelburne street extensions sufficient pipe and other material has been obtained to enable the commencement of the work before the opening of navigation.

FINANCIAL.

The receipts for the past year amount to \$36,085.87, a falling off from last year of \$3,344.50. This falling off, instead of the usual increase, is due to the recent change of rates and the unusually large amount of unpaid bills, \$3,110.00, due the department from public funds not having been paid. The water rates for the year, paid and unpaid, exceed the current expense, including interest on bonds and reservoir notes, by \$9,823.62.

CONSUMPTION.

The pumping record for the past year shows an increase of nearly fifty million gallons in the annual pumpage. This increase is in a measure accounted for by the intense cold of last winter and the consequent waste.

For a number of years past, the rapid increase in the number of metered services and the gradual placing of inveterate wasters of water on the metered list, has kept our consumption within the capacity of the pumps to supply.

With our gradual, but steady, increase in population, this condition of affairs, even with the increase in the number of metered consumers resulting from the recent changes in rates, cannot long continue. We again feel called upon to bring the matter to your attention, and to ask the co-operation of your Honorable Board and of our citizens generally in our efforts to check useless waste.

For particulars relative to the work of the department, the accompanying annual report of the Superintendent is referred to.

Respectfully submitted,

A. H. PARKER,	} Water	
L. C. GRANT,		} Commissioners.
W. E. HALL,		

TWENTY-SEVENTH ANNUAL REPORT
OF THE
Superintendent of Water Works.

*To the Honorable the Board of Water Commissioners of the
City of Burlington, Vermont :*

GENTLEMEN : The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending Dec. 31st, 1893 :

FUNDS AVAILABLE FOR THE USE OF THE WATER
DEPARTMENT.

Balance from 1892-----	\$	66
Sale of pipe, meters, etc-----		3,094 71
Appropriations-----	21,550 00	
	<u> </u>	<u>\$24,645 37</u>

RECEIPTS.

From G. D. Weller, City Treasurer---	\$ 5,259 86
From E. C. Mower, City Treasurer----	19,382 99
	<u> </u> <u>\$24,642 85</u>

Unexpended balance-----	\$	2 52
-------------------------	----	------

DISBURSEMENTS.

Construction :—

Cast iron pipe, packing and lead-----	\$	927 68
Gates and material for blasting -----		36 97

Gate and cut-off boxes-----	\$100 00
Service pipe and fittings-----	372 25
Labor on services-----	474 90
Labor on mains-----	902 15
	<hr/> \$ 2,813 95

Current :—

Pay rolls-----	\$ 3,298 82
F. H. Crandall, Superintendent, salary one year-----	1,000 00
Material for management and repairs--	714 31
Office expenses-----	276 29
Miss Minnie S. Moore, salary eleven months -----	366 63
Printing, advertising and postage-----	250 96
Horses, keeping, shoeing, repairs, etc--	351 87
Prof. Sedgwick, professional services--	20 00
Material purchased and used for and at the expense of others-----	147 12
Hydrants -----	200 00
Repair of Hydrants-----	204 43
Bills for labor-----	252 09
Gate and cut-off boxes-----	383 41
Freight and express charges-----	80 07
Repair of tools-----	64 27
Iron watering troughs-----	84 99
Hot water and office furnishings-----	399 12
Replacing cement pipe :—	
Cast iron pipe-----	\$2,173 31
Labor-----	3,530 00
Gates -----	544 27
Packing and lead-----	172 21
	<hr/> \$6,419 79
	<hr/> \$14,514 17

Pumping :—

Fuel-----	\$3,069 75
Pay rolls-----	2,026 00
Repairs to machinery-----	167 32
Supplies-----	101 81
Repairs to motor-----	261 24
Repairs to buildings and grounds-----	50 45
	<hr/> \$ 5,676 57

Meters :—

Meters-----	\$ 956 05
Pay rolls-----	573 35
Repairs and freight-----	108 76
	<hr/> \$ 1,638 16

RECAPITULATION.

Construction-----	\$ 2,813 95
Current, regular-----	\$14,514 17
" pumping-----	5,676 57
" meter-----	1,638 16
	<hr/> \$21,828 90
	<hr/> \$24,642 85

NORTH AVENUE, INTAKE AND SHELBURNE
STREET EXTENSIONS.AVAILABLE FUNDS FOR THE USE OF THE WATER
DEPARTMENT.

Appropriation authorized by city meeting----- \$58,000 00

RECEIPTS.

From E. C. Mower, City Treasurer-----	5,634 60
	<hr/>
Balance to 1894-----	\$52,365 40

DISBURSEMENTS.

Printing, advertising and other expenses incident to letting contract for Intake extension-----	\$ 145 71
For fire protection extensions, pipe and specials -----	\$ 4,983 80
Lead, yarn and labor-----	505 09
	<u>\$ 5,488 89</u>
	<u>\$ 5,634 60</u>

WATER TAX COLLECTIONS.

RECEIPTS.

From collections of meter rates-----	\$20,049 95
From collections of schedule rates-----	16,035 92
	<u>\$36,085 87</u>

DISBURSEMENTS.

Paid G. D. Weller, City Treasurer----	\$ 3,800 00
Paid E. C. Mower, City Treasurer----	32,285 87
	<u>\$36,085 87</u>

We hereby certify that we have examined the vouchers and accounts of F. H. Crandall, Superintendent of City Water Works, from January 1st to December 31st, 1893, and find the same correct.

GEO. W. BECKWITH,	} City Auditors.
C. F. GROVER,	
S. R. WAGER,	

WATER PUMPED.

1893.	Gallons.
January-----	30,331,900
February-----	26,833,000
March-----	27,705,625

April-----	27,479,700
May-----	26,238,550
June-----	35,525,900
July-----	32,414,225
August-----	24,274,475
September-----	30,066,300
October-----	26,526,675
November-----	20,761,400
December-----	29,335,600

Total 1893-----	337,493,350
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Total 1892-----	288,090,575
-----------------	-------------

Increase in 1893-----	49,402,775
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Daily average in 1893-----	924,639
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Daily average in 1892-----	789,639
----------------------------	---------

SERVICES.

There have been added 80 services of the following sizes :

Four-----	4	inch.
Two-----	2	"
One-----	1½	"
One-----	1¼	"
Two-----	1	"
Five-----	¾	"
Sixty-five-----	½	"

One 1-inch and 6 ½-inch services have been discontinued.

HYDRANTS.

Six Lang post hydrants, located as follows, have been set during the past season :

Winooski avenue, corner of Main street.

Willard, corner of Loomis street.

Park avenue, west of Briggs street.

In rear of Mary Fletcher Hospital, Colchester avenue.

In front of Mary Fletcher Hospital, Colchester avenue.

In front of Electric railway car sheds, North Winooski avenue.

Of the above, the last three are private hydrants, set at the expense of the parties whose property they are primarily designed to protect.

Three public hydrants between the tracks in the railroad yard have been discontinued.

Ground hydrants have been replaced at the intersection of Archibald street with Intervale and Winooski avenues.

Total number of public hydrants-----	148
“ “ private “ -----	27

Total -----	175
-------------	-----

SUPPLY PIPE.

Two hundred feet of 1-2 inch galvanized iron supply pipe, in Peru and Hyde streets, have been discontinued since the laying of cast iron mains in those streets.

Total length now in use-----	21,569 feet.
------------------------------	--------------

MAINS.

New mains have been laid in the following streets :

WITH FOUR-INCH CAST IRON PIPE.

Hickok Place, easterly from dead end-----	124 feet.
Johnson street, southerly from Peru street-----	30 “
Greene street, northerly from Hickok Place-----	424 “
Orchard Terrace, southerly from end of 6-inch pipe--	444 “
St. Louis street, southerly from North Bend-----	122 “
Decatur street, easterly from Intervale avenue-----	40 “

WITH SIX-INCH CAST IRON PIPE.

Peru street, westerly from Elmwood avenue-----	430 feet.
Archibald street, easterly from Winooski avenue---	338 "
Hyde street, southerly from Archibald street-----	180 "
North Willard street, northerly from dead end-----	210 "
Loomis street, easterly from Willard street-----	422 "
Orchard Terrace, southerly from Pearl street-----	26 "
Winooski avenue, northerly from Main street-----	46 "
Park avenue, westerly from dead end-----	234 "

Total length of new mains-----3070 feet.

The cement pipe in the following streets has been replaced during the past season :

WITH SIX-INCH CAST IRON PIPE.

Intervale avenue, southerly from Archibald street--	730 feet.
Spring street, westerly from Intervale avenue-----	473 "
Walnut street, northerly from Spring street-----	168 "
Archibald street, at Walnut and Intervale avenue--	175 "
Winooski avenue, northerly from Decatur street---	800 "
Hyde street, northerly from Pomeroy street -----	263 "
Peru street, easterly from Champlain street-----	520 "
Elmwood avenue, northerly from Grant street-----	200 "
Murray street, northerly from Peru street-----	20 "
George street, southerly from Peru street-----	30 "
Grant street, easterly from Elmwood avenue-----	52 "
Colchester avenue, at Green Mount Cemetery-----	400 "
Cherry street, easterly from Church street-----	33 "
Union street, southerly from Winooski avenue----	40 "
Winooski avenue, at Pearl street-----	60 "

WITH TEN-INCH CAST IRON PIPE.

Main street, easterly from end of iron pipe near

Union street-----1046 feet.

North avenue, northerly from North street----- 500 "

Total length of cement pipe replaced-----5510 feet.

LENGTH OF PIPE NOW IN USE.

Cement-----75,546 feet.

Iron-----94,171 "

Total feet of pipe-----169,717

Total miles of pipe----- 32.14

GATES.

The following gates have been discontinued :

Archibald street, at Intervale avenue----- 2 4 inch.

Crombie street, at Intervale avenue----- 1 4 "

George street, at Peru street----- 1 4 "

Spring street, at Intervale avenue----- 1 4 "

Grant street, at Elmwood avenue----- 1 3 "

Cherry street, at Church street ----- 2 3 "

Winooski avenue, at Archibald street----- 1 4 "

Main street, at Union street----- 1 10 "

Willard street, at Main street----- 1 4 "

Colchester avenue at Green Mount Cemetery----- 1 6 "

Total ----- 12

The following gates have been set during the past season :

North avenue, at north line of North street----- 1 10 inch.

" " south line of Strong street----- 1 10 "

Main street, at east line of Union street----- 1 10 "

" " " " Willard street----- 1 10 "

" " at west line of Willard street----- 1 10 "

Main street at west line of Union street-----	1	10 inch.
Willard street, at south line of Loomis st-----	1	6 "
Loomis street, at east line of Willard street-----	1	6 "
Pearl street, at east line of Winooski avenue-----	1	6 "
" " at west " " "-----	1	6 "
Winooski avenue, at north line of Pearl street----	1	6 "
Cherry street, at east line of Church street-----	1	6 "
Orchard Terrace, at south line of Pearl street----	1	6 "
Park avenue at west line of Briggs street-----	1	6 "
Archibald street, at east line of Intervale avenue--	1	6 "
" " at west " " "-----	1	6 "
" " at east line of Walnut street-----	1	6 "
Interval avenue, at south line of Archibald street--	1	6 "
" " " " Spring street-----	1	6 "
Spring street, at west line of Intervale avenue----	1	6 "
Walnut street, at south line of Archibald street----	1	6 "
Elmwood avenue, at north line of Grant street----	1	6 "
Grant street, at east line of Elmwood avenue----	1	6 "
Peru street, at west line of " "-----	1	6 "
" " " " George street-----	1	6 "
George street, at south line of Peru street-----	1	6 "
Murray street, at north line of Peru street-----	1	6 "
North Winooski avenue, at south line of Archibald street -----	1	6 "
Winooski avenue, at north line of Archibald street	1	6 "
Archibald street, at east line of North Winooski avenue-----	1	6 "
Archibald street, at west line of North Winooski avenue-----	1	6 "
Hyde street, at south line of Archibald street----	1	6 "
Union street, at east line of Winooski avenue----	1	6 "
Colchester avenue, at Mansfield avenue-----	1	6 "

Colchester avenue, at Chase street-----	1	6 inch.
Colchester avenue, at Green Mount cemetery-----	1	6 "
Winooski avenue, at east line of Main street-----	1	6 "
Decatur street, at east line of Intervale avenue---	1	4 "
Crombie street, at east line of Intervale avenue---	1	4 "
Johnson street, at south line of Peru street-----	1	4 "
Willard street, at south line of Main street-----	1	4 "
Hikok Place, at west line of Greene street-----	1	4 "
Chase street, near school house-----	1	4 "
Barrett street, at Colchester avenue-----	1	4 "
St. Louis street, at North Bend street-----	1	4 "
On fire services for the Hospital, the Hartshorn Co., the Electric Railway Co., and The Lang & Goodhue M'f'g Co. there have been set-----		
	4	4 "

Total added-----49

Total now in use-----383

Repairs for the year have been :—

On cement pipe-----	18 breaks.
On cement pipe-----	9 leaks.
On iron pipe-----	9 joint leaks.
On iron pipe-----	1 plug leak.
On service pipe-----	14 leaks.
On broken hydrants-----	14 leaks.
On broken gates-----	4 leaks.

METERS.

There are now in use 876 meters, an increase of 165 over last year. Of the water pumped, 24.7 per cent. has been used through meters, yielding 55.56 per cent. of the collections.

All of which is respectfully submitted.

F. H. CRANDALL,
Superintendent.

LIST OF PUBLIC AND PRIVATE HYDRANTS.

LOCATION.						PUB. P. G.	PRI. P. G.
North lumber yard, north of Crane's office-----							I
"	"	"	"	"	"	-----	I
"	"	"	"	"	"	-----	I
"	"	"	"	"	"	-----	I
"	"	"	"	"	"	-----	I
"	"	"	"	"	"	-----	I
"	"	"	"	"	"	-----	I
"	"	"	"	at	"	-----	I
"	"	"	"	east	" mill	-----	I
"	"	"	"	"	" shed	-----	I
"	"	"	"	south	" box shop	-----	I
"	"	"	"	west	"	-----	I
On dock, bet. Crane's mill and pump-house-----							I
Between Crane's mill and pump-house-----							I
"	"	"	"	"	"	-----	I
In yard of pump-house-----							I
Lake street, opposite Booth's old office-----							I
"	"	"	"	at Booth's old office between tracks--			I
"	"	"	"	opposite old Round-house-----			I
"	"	"	"	at Booth's retail shed-----			I
"	"	"	"	at watering trough-----			I
"	"	"	"	north of Booth's office-----			I
"	"	"	"	south of Booth's office-----			I
"	"	"	"	south of Booth's boilers-----			I
"	"	"	"	at glazing shop-----			I
"	"	"	"	north of Depot, between tracks-----			I
"	"	"	"	corner College street-----			I
Foot of College street, west of tracks-----							I
Lake street, corner of Main street-----							I
North avenue, near J. Wakefield's-----							I

LOCATION.	PUB. P. G.	PRI. P. G.
North avenue, near R. R. tunnel-----	1	
" corner North Bend-----	1	
" corner North street-----	1	
Front street, corner North street-----	1	
Blodgett street, corner Strong street-----	1	
North Battery street, corner Poplar street-----		1
" " " " North street-----	1	
" " " " Smith's Lane-----	1	
South Battery street corner Cherry street-----	1	
" " " " Bank street-----	1	
" " " " Main street-----	1	
" " " " King street-----	1	
" " " " Maple street-----	1	
North Champlain street, corner Cedar street-----	1	
" " " " North street-----	1	
" " " " Peru street-----	1	
" " " " Pearl street-----	1	
South Champlain street, corner Bank street-----	1	
" " " " College street---	1	
" " " " Main street-----	1	
" " " " King street-----	1	
" " " " Maple street-----	1	
" " " at Brewery-----	1	
" " " at Skilling's mill-----	1	
Rose street, corner North Bend-----		1
Murray street, corner Allen street-----	1	
Lafountain street, corner Cedar street-----	1	
Head of George street, on Peru street-----	1	
George street, corner Pearl street-----	1	
Pine street, corner Cherry street-----	1	

LOCATION.		PUB. P. G.	PRI. P. G.
Pine street, corner College street-----		I	
“ “ “ King street-----		I	
“ “ “ Maple street-----		I	
“ “ at Venetian Blind shop-----		I	
“ “ at Burlington Cotton mills-----		I	
“ “ in yard of Burlington cotton mills--			I
“ “ below E. S. Adsit's coal yard-----		I	
“ “ below Gay & Henderson's coal yard		I	
“ “ corner Howard street-----		I	
“ “ east of Bronson, Weston & Dunham's mill-----			I
“ “ east of Bronson, Weston & Dunham's mill-----			I
“ “ west of Bronson, Weston & Dunham's mill-----			I
“ “ west of Bronson, Weston & Dunham's mill-----			I
“ “ west of Bronson, Weston & Dunham's mill-----			I
“ “ west of Bronson, Weston & Dunham's mill-----			I
“ “ west of Bronson, Weston & Dunham's mill-----			I
“ “ west of Bronson, Weston & Dunham's mill-----			I
St. Paul street, corner Pearl street-----		I	
“ “ “ Cherry street-----		I	
“ “ “ Bank street-----		I	
“ “ “ College street-----		I	
“ “ “ Main street-----		I	

LOCATION.		PUB. P. G.	PRI. P. G.
St. Paul street.	corner Maple street -----	1	
"	" foot of Adams street -----	1	
"	" in yard of Burlington Cotton mills		1
"	" corner Spruce street -----	1	
"	" between Marble and Howard sts.	1	
"	" corner Howard street -----	1	
North Bend,	North of corner Spring street -----	1	
Elmwood avenue,	corner Spring street -----	1	
"	" " North street -----	1	
"	" foot of Grant street -----	1	
Intervale avenue,	corner Oak street -----	1	
"	" " Archibald street -----	1	
"	" " Spring street -----	1	
Church street,	corner Pearl street -----	1	
"	" " Cherry street -----	1	
"	" " Bank street -----	1	
"	" " College street -----	1	
"	" " Main street -----	1	
"	" " King street -----	1	
"	" " Adams street -----	1	
Bright street,	corner First street -----	1	
North Winooski avenue,	corner First street -----	1	
"	" " at Car barn -----		1
"	" " corner Archibald street -----	1	
"	" " Decatur street -----	1	
"	" " North street -----	1	
"	" " Grant street -----	1	
South Winooski avenue,	corner Pearl street -----	1	
"	" " between Cherry and Bank		
streets	-----	1	

LOCATION.				PUB. P. G.	PRI. P. G.
South Winooski avenue, corner College street----	I				
“ “ “ “ Main street-----	I				
North Union street, corner North street -----	I				
“ “ “ “ Loomis street -----	I				
“ “ “ head of Grant street -----	I				
“ “ “ corner Pearl street-----	I				
South Union street, corner College street -----	I				
“ “ “ “ Main street -----	I				
“ “ “ “ Maple street -----	I				
“ “ “ “ Adams street-----	I				
“ “ “ “ Spruce street-----	I				
“ “ “ “ Bay View street-----	I				
“ “ “ “ Howard street-----	I				
“ “ “ “ St. Paul street -----	I				
Hyde street, corner Pomeroy street -----	I				
School street, corner North street -----	I				
E. W. Peck, 326 College street-----					I
North Willard street, corner Archibald street-----	I				
North street, east of North Willard street-----					I
North Willard street, corner Loomis street-----	I				
“ “ “ “ Pearl street-----	I				
South Willard street, corner College street-----	I				
“ “ “ “ Main street-----	I				
“ “ “ “ Maple street -----	I				
“ “ “ “ Spruce street -----	I				
“ “ “ foot of Cliff street-----	I				
“ “ “ corner Howard street -----					I
“ “ “ “ Ledge road-----	I				
Shelburne street, near No. 80 -----					I
“ “ “ “ 124 -----	I				

LOCATION.	PUB. P. G.	PRI. P. G.
Shelburne street near, head of Park avenue -----	I	
Park avenue, corner Briggs street-----	I	
“ “ at Lang's shop -----	I	
Briggs street-----	I	
Hayward street, corner Howard street-----	I	
Williams street, on premises of A. E. Richardson		I
“ “ between Pearl and College street	I	
“ “ corner College street -----	I	
“ “ “ Main street -----	I	
Summit street. corner Maple street -----	I	
North Prospect street. near Pomeroy street-----	I	
“ “ corner North street -----	I	
“ “ “ Loomis street-----	I	
South Prospect street corner Pearl street -----	I	
“ “ “ College street -----	I	
“ “ “ Main street -----	I	
“ “ south of Maple street-----	I	
“ “ “ Cliff street -----	I	
Mansfield avenue, corner Loomis street-----	I	
University place. at Library-----	I	
“ south end of College-----	I	
Colchester avenue, near Spear Hose-----	I	
“ opposite Hospital -----	I	
“ at Hospital -----		I
“ “ -----		I
“ foot of East avenue -----	I	
“ near Cemetery-----	I	
“ corner Chase street-----	I	
“ below Barrett street-----	I	
Barrett street, corner Chase street-----	I	

LOCATION.				PUB. P. G.	PRI. P. G.
Grove street-----				I	
Mill street, Burlington Cotton Mills-----					I
"	"	"	"-----		I
"	"	"	"-----		I
				123	25 23 4
Number of public hydrants-----				148	
Number of private hydrants-----					27
Total number of hydrants -----					175

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association,

For the Year 1893.

Burlington City Water Works.
 Burlington, Chittenden County, Vermont.
 Population by U. S. census, 1890, 14,590.
 Works constructed 1867-8.
 Owned by city.
 Source of supply, Lake Champlain.
 Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel.

{	<i>a</i> Anthracite. <i>c</i> Grate. <i>d</i> Pittston. <i>e</i> \$5.20 and 5.45.	}
---	--	---

 25 weeks.
 g Mill shavings, \$36 and \$38.50 per week,
 27 weeks.
6. Total pumpage for the year, 337,493,350 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
 Cost of pumping figured on pumping station expenses,
 \$5,676.57.
11. Per million gallons raised against dynamic head into reservoir, \$16.82.
12. Per million gallons raised one foot high (dynamic),
 \$0.0532.

Cost of pumping figured on total maintenance,
\$30,778.90.

13. Per million gallons raised against dynamic head into reservoir, \$91.19.

14. Per million gallons raised one foot high (dynamic), \$0.288.

FINANCIAL.

Division I.

MAINTENANCE.

Receipts.		Disbursements.	
From Consumers.		AA. Management and repairs	\$21,828 90
A. Water rates, domestic.	\$31,242 81	BB. Interest on bonds	8,200 00
B. Water rates, manufacturing	4,568 26	Interest on reservoir notes	750 00
From public funds.		CC. Total maintenance	\$30,778 90
*C. Hydrants	\$2,900 00	DD. Balance to the City Treasurer	8,401 68
*D. Fountains and Parks	75 00		
E. Watering Troughs	250 00		
*F. Public Buildings	75 00		
G. Net receipts for water	\$38,085 87		
H. Sale of pipes, meters, etc.	8,094 71		
I. Gross receipts	\$39,180 58	EE. Total	\$39,180 58

*Not paid.

Division II.

From fixed rates.	L. Domestic	\$15,935 92
	M. Manufacturing	100 00
	N.	\$16,035 92
From meter rates.	O. Domestic	\$15,556 69
	P. Manufacturing	4 493 26
	Q.	\$20 049 95
Total		\$36,085 87

CONSTRUCTION.

Receipts.		Disbursements.	
T. Appropriation	\$2,818 95	FF. Extension of mains	\$1,918 95
		GG. Extension of services	900 00
V. Total	\$2,818 95	KK. Total	\$2,818 95

W. Cost of works to date ----- \$376,770 89

X. Bonded debt at date ----- 190,000 00

Y. *Value of sinking fund at this date----- 121.742 84

Z. Rate of interest, four and five per cent.

*Toward paying the entire bonded debt of the city, \$422,000.00.

CONSUMPTION.

1. Estimated total population at date, 15 300.
2. " " " on lines of pipe. 14 900.
3. " " " supplied. 14 600.
4. Total number of gallons consumed for year. 337 493,350.
5. Passed through domestic meters 56 052,120 gallons, or 16.6 per cent.
6. Passed through manufacturing meters, 27,312,165 gallons. or 8.1 per cent.
7. Average daily consumption, 924,639 gallons.
8. Gallons per day to each inhabitant 60.
9. Gallons per day to each consumer, 62.
10. Gallons per day to each tap, 338.

DISTRIBUTION.

MAIN.

1. Kind of pipe, cement lined, cast iron, wrought iron.
2. Size, from 4 to 16 inches.
3. Extended, 8580 feet.
4. Discontinued, 5510 feet.
5. Total now in use, 32.14 miles.
6. Cost of repairs per mile, \$12.14.
7. Leaks per mile, 1.0.
8. Small distribution pipe less 2 than 4 inch, total length, 21,569 feet.
9. Hydrants added, 6.
10. Number now in use, 175.
11. Stop gates added, 49.
12. Number now in use, 383.
13. Small stop gates less than 4 inch, total, 70.
14. Number of blow-off gates, 6.
15. Range of pressure on mains at centre, for day and night, 70 to 85 pounds.

SERVICES.

16. Galvanized iron, lead.
17. From $\frac{1}{2}$ to 6 inches.
18. 2235 feet.
19. 210 feet.
20. 14.8 miles, or 78,131 feet.
21. Service taps added, 8.
22. Number now in use, 2737.
23. Average length of service, 28 feet.
24. Average cost of service, \$8.25.
25. Meters added, 165.
26. Number now in use, 876.
 - a. domestic, 813.
 - b. manufacturing, 63.
27. Motors and elevators added, 1.
28. Number now in use, 17.

STORAGE.

Earthwork reservoirs, low service, capacity, 7 000,000 gallons.

Iron tank. high service, capacity, 169,617 gallons.

1892.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by U. S. census, 1890, 14,590.

Works constructed 1867-8.

Owned by the city.

Source of supply, Lake Champlain.

Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel, $\left\{ \begin{array}{l} a \text{ Anthracite.} \\ b \text{ Grate.} \\ d \text{ Pittston.} \\ e \text{ \$5.20.} \\ g \text{ Mill Shavings, \$36 per week, 23 weeks.} \end{array} \right\} 29 \text{ weeks.}$
6. Total pumpage for the year, 288,090.575 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
- Cost of pumping figured on pumping station expenses, \$5,600.96.
11. Per million gallons raised against dynamic head into reservoir, \$19.45.
12. Per million gallons raised one foot high (dynamic), \$0.0615.
- Cost of pumping figured on total maintenance, \$27,869.88.

13. Per million gallons raised against dynamic head into reservoir, \$96.77.
14. Per million gallons raised one foot high (dynamic), \$0.306.

FINANCIAL.**Division I. MAINTENANCE.**

Receipts.		Disbursements.	
From Consumers.		AA. Management and repairs.	
A. Water rates, domestic.	\$34,400 00	BB. Interest on bonds and reservoir notes	\$18,734 88
B. Water rates, manufacturing.	4,430 37	CC. Total maintenance for year.	\$27,869 88
From public funds.		DD. Balance to the City Treasury	12,400 24
C. Hydrants.	\$1,200 00		
D. Fountains and Parks.	75 00		
E. Watering Troughs.	250 00		
F. Public Buildings.	75 00		
	\$ 1,600 00		
G. Net receipts for water.	\$39,490 37		
H. Sale of pipes, meters, etc.	809 75		
I. Gross receipts	\$40,330 12	EE. Total	\$40,330 12

Division II.

From fixed rates.	{	L. Domestic----	\$19,607 80
		M. Manufacturing	100 00
			<hr/>
		N.-----	\$19,707 80
From meter rates.	{	O. Domestic----	\$16,623 57
		P. Manufacturing	3,099 00
			<hr/>
		Q.-----	\$19,722 57
			<hr/>
		Total-----	\$39,430 37

CONSTRUCTION.

Receipts.		Disbursements.	
T. Appropriation from tax levy	\$1,107 89	FF. Extension of mains.	\$ 857 89
		GG. Extension of services.	250 00
V. Total	\$1,107 89	KK. Total	\$1,107 89

W. Cost of Works to date	\$373,956 94
X. Bonded debt at date	190,000 00
*Y. Value of sinking fund at this date	110,415 49
Z. Rate of interest, 4, 5 and 6 per cent.	

*For meeting the entire bonded debt of the city, \$415,000.

CONSUMPTION.

1. Estimated total population at date, 15,000.
2. Estimated total population on lines of pipe, 14,600.
3. Estimated total population supplied, 14,300.
4. Total number of gallons consumed for year, 288,090,575.
5. Passed through domestic meters, 43,213,568 gallons or 15 per cent.
6. Passed through manufacturing meters, 14,404,522 gallons, or 5 per cent.
7. Average daily consumption, 789,289 gallons.
8. Gallons per day to each inhabitant, 53.
9. Gallons per day to each consumer, 55.
10. Gallons per day to each tap, 303.

DISTRIBUTION.

MAINS.

1. Kind of pipe, cement lined, cast iron, wrought iron.
2. Size, from $\frac{1}{2}$ to 16-inch.
3. Extended, 3898 feet.
4. Discontinued, 3283 feet.
5. Total now in use, 31.56 miles.
6. Cost of repairs per mile, \$9.
7. Leaks per mile, .5.
8. Small distribution pipe less than 4 inches, total length, 21,769 feet.
9. Hydrants added, none.
10. Number now in use, 172.
11. Stop gates added, 22.
12. Number now in use, 347.
13. Small stop gates less than 4 inches, total 68.
14. Number of blow off gates, 5.
15. Range of pressure on mains at centre, for day and night, 70 to 85 pounds.

SERVICES.

16. Galvanized iron, lead.
17. From $\frac{1}{2}$ to 4 inches.
18. 1546 feet.
19. 46 feet.
20. 14.41 miles, or 76,106 feet.
21. Service taps added, 57.
22. Number now in use, 2664.
23. Average length of service, 28 feet.
24. Average cost of service, \$8.
25. Meters added, 57.
26. Number now in use, 711.
 - a. Domestic, 665.
 - b. Manufacturing, 46.
27. Motors and elevators removed, 1.
28. Number now in use, 17.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons.

Iron tank, high service, capacity 169,617 gallons.

Albert F. Mayer

TWENTY-EIGHTH

ANNUAL REPORT

OF THE

Water Department

OF THE

CITY OF BURLINGTON, VT.,

DECEMBER 31, 1894.

BURLINGTON :
FREE PRESS ASSOCIATION,
PUBLISHERS, PRINTERS AND BOOKBINDERS.
1895.

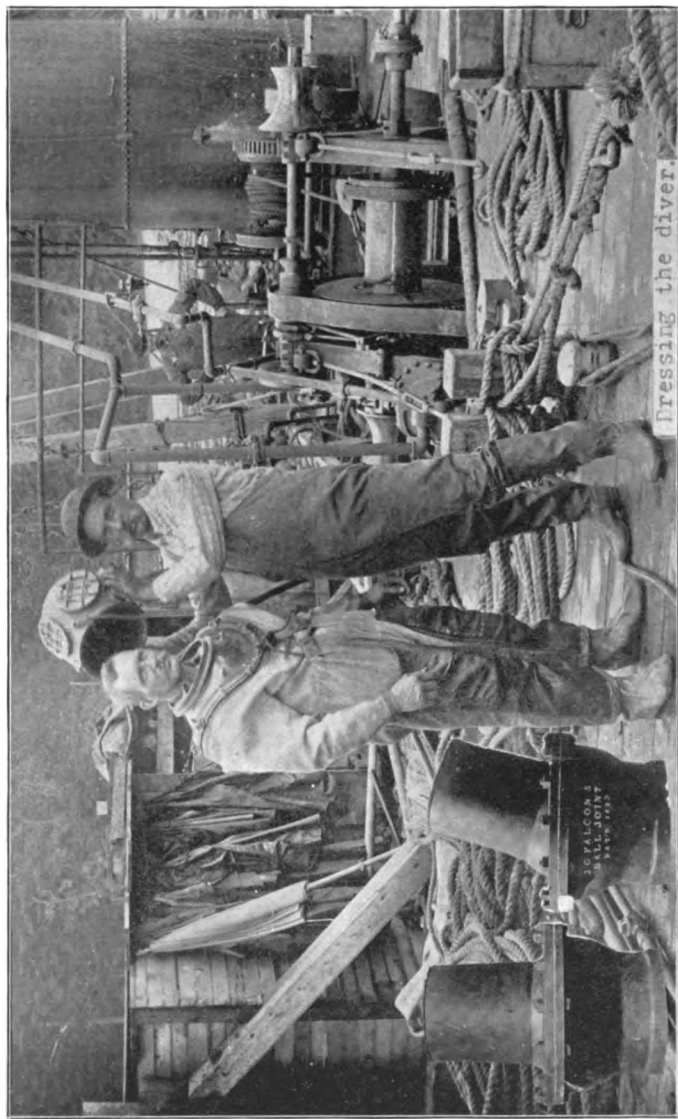
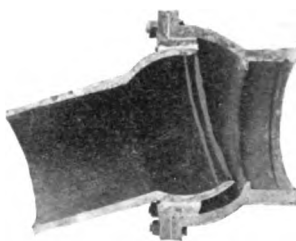
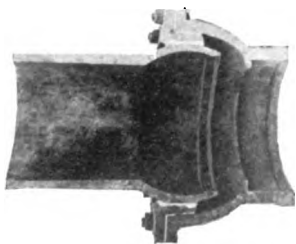
Compliments of

J. A. Crandall, Supt.

Please exchange.

Hope to see you at the annual meeting of the New England Water Works
Association, to be held in this city June 19, 20, 21.

F. H. C.



F. R. Menns, Photographer.

Machinery and Flexible Joints used in laying the Intake Conduit.

TWENTY-EIGHTH

ANNUAL REPORT

OF THE

Water Department

OF THE

CITY OF BURLINGTON, VT.,

DECEMBER 31, 1894.

BURLINGTON:
FREE PRESS ASSOCIATION,
PUBLISHERS, PRINTERS AND BOOKBINDERS.
1895.

SIXTH ANNUAL REPORT
OF THE
Water Commissioners.

To the Honorable the Board of Aldermen, City of Burlington :

GENTLEMEN:—In compliance with the City Ordinance the Water Commissioners respectfully submit the following, their report for the year ending December 31st, 1894 :

FINANCIAL.

The water collections for the past year, \$41,304.84, together with the bills unpaid January 1st, 1895, \$5,499.38, of which \$3,565.00 are due from public funds, exceed the current expenses of the department, interest on notes and bonds included, by \$7,315.25.

The item of interest in the current expenses of 1895 will, on account of bonds sold on July 1st and October 1st of the year just closed, be \$1,835.00 in excess of that item for this year. What effect the current expenditure for the year will have upon the financial standing of the department cannot be predicted until more is known relative to the work which will be required.

PUMPING STATION.

The initial steps have been taken towards securing sufficient ground around the Pumping Station for the accommodation of new and larger pumping machinery, when it shall be required, as also for the adequate protection of this most essential feature of our system of fire protection.

WATER RATES.

Under ordinary conditions the present rates afford enough revenue to meet the current expenditures of the department and turn a small balance, sufficient to meet any unexpected increase of expenses or loss of revenue, into the treasury.

Our attention has from time to time been directed to certain inequalities of the rates, notably to the fact, that under certain conditions a premium is offered for the waste of water by meter takers.

We hope in the near future to recommend changes, which, without materially affecting the rate of assessment or the receipts of the department, will do away with certain objectionable features, which have come to our notice.

EXTENSIONS.

It will be a matter of satisfaction to all and of surprise to many that the cost of the intake, North avenue and Shelburne street extensions, has not exceeded the appropriation made for those purposes.

The main pipes of the Colchester avenue and Pine street extensions have been laid, notwithstanding the late date at which the work was ordered, but the transferring of services and the making of some connections remains to be done another season.

The intake extension, for which bids were received in 1893, was completed during the past season and has been in satisfactory operation for several months.

Aside from the satisfaction, which all must derive from the knowledge that our water supply is obtained from a point so far removed from any possibility of contamination, many think that they can detect an improvement in quality.

The physicians report the public health to be much better than usual at this time of the year, and attribute the improvement to the transferring of the intake from the bay to its present, more healthful position in the more frequently agitated waters of the broad lake.

Even those who feel that in so far as the improvement of the quality of the city water is concerned, there was no occasion for the recent expenditure, inasmuch as by it, all question as to the purity of the supply is removed, endorse the general opinion that the \$47,239.46 expended on the intake extension was money well invested.

The season was an exceptionally fine one for the work, which, when all was in readiness, went forward with scarcely any delay.

Giving to the exceptionally favorable season all due credit the real reason for the rapidity with which the undertaking was prosecuted to satisfactory completion, is to be found in the knowledge and experience in such work, which the contractor, Mr. Jos. G. Falcon of Evanston, Ill., brought to bear on both, the preparation for and the execution of his contract.

Respectfully,

HENRY GREENE,	}	Water Commissioners.
W. E. HALL,		
J. E. LANOU,		

TWENTY-EIGHTH ANNUAL REPORT
OF THE
Superintendent of Water Works.

*To the Honorable the Board of Water Commissioners of the
City of Burlington, Vt.:*

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31st, 1894 :

**FUNDS AVAILABLE FOR THE USE OF THE WATER
DEPARTMENT.**

Balance from 1893.....	\$	2	52
Sale of pipe, meters, etc.....		1,763	15
Appropriations for general purposes....		32,800	00
Appropriations for Colchester avenue and Pine street.....		20,000	00
Balance from 1893 on appropriation for North avenue, Intake and Shelburne street.....		52,365	40
		<u> </u>	<u>\$106,931 07</u>

RECEIPTS FROM CITY TREASURER.

For general purposes.....	\$34,564	90
For North avenue, Intake and Shelburne street.....	52,365	40
For Colchester avenue and Pine street..	18,258	81
	<u> </u>	<u>\$105,189 11</u>

WATER DEPARTMENT.

7

Unexpended balance general account...	\$	77	
Unexpended balance Colchester avenue and Pine street.....		1,741	19
		<hr/>	\$ 1,741 96
			<hr/>
			\$106,931 07

DISBURSEMENTS.

GENERAL WATER WORKS ACCOUNTS.

Construction:

Cast iron pipe, packing and lead.....	\$	550	00
Hydrants.....		345	00
Service pipe and fittings.....		193	33
Labor on mains.....		787	86
Labor on services.....		511	05
Stops for cast iron pipe.....		200	02
Stops for cement pipe.....		79	65
Stop and gate boxes.....		30	87
		<hr/>	\$ 2,697 78

Current:

Pay rolls.....	\$3,330	04
F. H. Crandall, Supt., salary one year..	1,000	00
Material for management and repairs ..	862	87
Repair of hydrants.....	624	78
Plumbers' bills.....	546	20
Commissioners' salaries.....	535	53
Machinists' bills.....	534	20
Keeping of horses, shoeing, repairs, etc..	500	19
Bills for labor.....	460	30
Miss Minnie S. Moore, salary one year...	400	00
Reservoir repairs and grading.....	393	06
Hydrants.....	353	00
Cleaning and painting high service tank	311	48

Gate and stop boxes.....	\$	237	20	
Lumber.....		236	36	
Office expenses.....		230	07	
Horse, wagon and harnesses.....		205	40	
Printing, advertising and postage.....		159	30	
Hardware.....		151	77	
Freight and express charges.....		134	40	
Telephone rental.....		125	42	
Repairs of tools.....		105	96	
Rev. Thos Lynch, claim for damages...		25	00	
Replacing cement pipe :				
Cast iron pipe.....	\$5,096	11		
Labor.....	2,119	85		
Gates.....	942	51		
Lead and yarn.....	732	02		
				\$8,890 49
				<u>\$20,353 02</u>
<i>Pumping:</i>				
Fuel.....	\$4,665	98		
Pay rolls.....	1,985	75		
Repairs to machinery.....	431	92		
Repairs to motor.....	485	97		
Repairs to buildings.....	25	88		
Insurance.....	100	00		
Supplies.....	245	08		
				<u>\$7,940 58</u>
<i>Meters :</i>				
Meters.....	2,557	49		
Pay rolls.....	873	40		
Repairs and freight.....	142	63		
				<u>3,573 52</u>
				<u>\$34,564 90</u>

NORTH AVENUE INTAKE AND SHELburnE STREET EXTENSIONS.

North Avenue and Shelburne Street :

Pay rolls.....	\$4,233 29
Pipe and specials.....	651 49
Gates.....	253 06
Packing, freight and incidentals	93 31
Material for blasting.....	40 50
	<hr/> \$5,271 65

Intake :

Paid J. G. Falcon, contractor.....	\$24,850 08
Paid material for the contractor	22,085 92
House on intake well	67 25
Work on plans and location	38 85
Inspection.....	51 65
	<hr/> \$47,093 75
	<hr/> \$52,365 40

COLCHESTER AVENUE AND PINE STREET EXTENSIONS.

Cast iron pipe.....	\$9,355 35
Time on pay rolls.....	6,054 85
Packing, lead and gates	1,880 43
Freight and cartage.....	624 84
Tools and supplies.....	189 55
Repairs of tools.....	60 00
Lumber.....	56 79
Engineering work.....	20 00
Bills for labor.....	17 00
	<hr/> \$18,258 81
Total disbursements.....	<hr/> \$105,189 11

RECAPITULATION.

General water works construction.....	\$ 2,697 78
Current, regular.....	\$20,353 02
" pumping.....	7,940 58
" meters.....	3,573 52
	<u>31,867 12</u>
	<u>\$34,564 90</u>

North avenue, Intake and Shelburne street Extensions :

North Ave. and Shelburne St.....	\$ 5,271 65
Intake.....	47,093 75
	<u>\$52,365 40</u>
Colchester Ave. and Pine St. extensions.....	18,258 81
	<u>\$105,189 11</u>

WATER TAX COLLECTIONS.

RECEIPTS.

From collections of meter rates.....	\$21,732 48
From collections of schedule rates.....	19,572 36
	<u>\$41,304 84</u>

DISBURSEMENTS.

Paid to City Treasurer.....	\$41,304 84
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FINANCIAL STATEMENT.

ASSESSMENTS :		EXPENSES :	
PAID.			
Water rates, schedule.....	\$19,572 36	Management and repairs... ..	\$11,462 53
Water rates, meter.....	21,732 48	Replacing cement pipe.....	8,890 49
Material and labor.....	1,763 15	Pumping.....	7,940 58
		Meters.....	3,573 52
		Interest.....	9,385 00
UNPAID.			
Public funds.....	3,565 00	Total maintenance.....	\$41,252.12
Consumers.....	1,934 38	Excess of assessments over ex-	
		penditures.....	7,315 25
	<u>\$48,567 37</u>		<u>\$48,567 37</u>

We hereby certify that we have examined the vouchers and accounts of F. H. Crandall, Superintendent of City Water Works, from January 1st, to December 31, 1894 and find the same correct.

GEO. W. BECKWITH, }
 JOHN C. FARRAR, } Auditors.
 CHAS. B. GRAY, }

WATER PUMPED.

1894.	Gallons.
January.....	23,958,675
February.....	21,953,825
March.....	23,776,750
April.....	25,981,300
May.....	27,271,475
June.....	33,628,700
July.....	32,300,600
August.....	32,496,775
September.....	32,499,925
October.....	28,856,050
November.....	24,083,050
December.....	29,697,600
Total 1894.....	336,504,725
Total 1893.....	337,493,350
Decrease in 1894.....	988,625
Daily average in 1894.....	921,930
Daily average in 1893.....	924,639

SERVICES.

There have been added 100 services of the following sizes:

Six.....	4	inch
Two.....	3	"

Seven.....	2	inch
One.....	1½	"
One.....	1	"
Six.....	¾	"
Seventy-seven.....	½	"

Two services have been discontinued.

HYDRANTS.

Sixteen Lang post hydrants have been set during the past season, located as follows :

St. Paul at King street.

So. Willard at Buell street.

Converse Court at Hickok place.

North avenue at Canfield street.

" " Ward street.

" " Providence Orphan Asylum.

" " Lake View Cemetery.

Shelburne street at Home for Destitute Children.

Lyman avenue on Scarff Addition.

Colchester avenue at the Ira Allen school.

" " Mansfield avenue.

Shelburne street in yard of Home for Destitute Children.

" " near No. 80.

Colchester avenue at Green Mount Cemetery.

" " East avenue.

Loomis at Prospect street.

Of the above, the last four replace ground hydrants and one, that in the yard of the Home for Destitute Children is a private hydrant, set at the expense of the Home.

Total number of public hydrants.....	159
Total number of private hydrants.....	28
Total.....	187

SMALL SUPPLY PIPE.

Seven thousand and six-nine feet of small distribution pipe in North avenue, East avenue, Convent square, Hickok place, North Bend, Haswell, Ward, Shelburne, and Buell streets, have been discontinued since the laying of cast iron mains in those streets.

Total length now in use..... 14,500 feet

MAINS.

New mains have been laid in the following streets :

WITH TWENTY-FOUR INCH PIPE.

Main street from the reservoir lot to Prospect street. 460 feet.
Prospect street, northerly from Main street..... 968 "

WITH TWENTY-INCH PIPE.

Prospect street, northerly from end of 24 inch..... 500 "

WITH SIXTEEN-INCH PIPE.

Main street, westerly from Prospect street..... 182 "
College street, westerly from Prospect street.. 71 "
Prospect street, northerly from end of 20 inch..... 25 "
In reservoir lot..... 90 "

WITH TWELVE-INCH PIPE.

Pine street, from Howard street to Lakeside avenue, 2,343 "

WITH TEN-INCH PIPE.

North avenue from Strong street to cemetery.... 3,000 "
Shelburne street, from Park avenue northerly..... 2,190 "

WITH EIGHT-INCH PIPE.

Lakeside avenue, westerly from Pine street.....	900 feet.
Howard street, easterly from Pine street.....	30 "

WITH SIX-INCH PIPE.

Ward street, easterly from North avenue.....	30 "
North Bend, easterly from North avenue.....	30 "
Shelburne street, from Park avenue to the Home...	1,635 "
Loomis street, from dead end to Prospect street	706 "
East avenue, southerly from Colchester avenue	60 "
Lyman avenue, easterly from Briggs street.....	365 "
Briggs street, southerly from dead end.....	16 "

WITH FOUR-INCH PIPE.

Walnut street, connecting dead ends.....	270 "
Hickok place, easterly from Union street.....	22 "
Buell street, westerly from Willard street.....	25 "
Summit street, southerly from Maple street.....	612 "
Convent square, easterly from North avenue.....	30 "
Haswell street, westerly from North avenue.....	40 "

Total length of new mains.....14,600 feet.

The cement pipe in the following streets has been replaced during the past season with cast iron pipe :

TEN-INCH.

Shelburne street, from St. Paul street southerly.....	770 feet.
Battery, from Main to Maple street.....	800 "
Colchester avenue, from East avenue to Green Mount Cemetery.....	1,265 "

TWENTY-INCH.

Colchester avenue, from Prospect street to Mansfield avenue.....	420 "
---	-------

FOURTEEN-INCH.

Colchester avenue, from Mansfield avenue easterly .. 700 feet.

TWELVE-INCH.

Colchester avenue, from end of 14 inch to East
avenue.....1,100 "

EIGHT-INCH.

St. Paul street, from Shelburne street northerly 36 "

SIX-INCH.

Barrett street, from Colchester avenue to Chase street 660 "
Chase street, westerly from Barrett street..... 325 "
Strong street, easterly from North avenue..... 35 "
Murray street, from North to Peru street..... 702 "
Allen street, from Murray street to Elmwood avenue 539 "

Total length of cement pipe replaced.....7,352 feet.

LENGTH OF PIPE NOW IN USE.

Cement..... 68,194 feet.
Iron.....116,123 "

Total feet of pipe.....184,317

Total miles of pipe..... 34.91

GATES.

The following gates have been discontinued :

Shelburne street, near No. 80..... 1 4 inch.
" " at Ledge road..... 1 4 "
St. Paul, at So. Union street..... 1 4 "
Barrett street, at Colchester avenue..... 1 4 "

Barrett street, at Chase street.....	1	4	inch.
Chase street, at Barrett street.....	1	4	"
Battery street, at Main street.....	1	4	"
Strong street, at North avenue.....	1	4	"
Fire services at Dunham's mill.....	3	4	"
Colchester avenue, at Mansfield avenue.....	1	6	"
Pine street, south of Howard street.....	1	8	"
Main street, at Battery street.....	1	10	"
Total.....		14	

The following gates have been set during the past season :

Intake pipe at Colchester reef.....	1	24	inch.
" " in well at the pumping station.....	1	24	"
Prospect street, at Main street.....	1	24	"
" south of Colchester avenue branch.....	1	20	"
Colchester avenue, at Prospect street.....	1	20	"
In gate house at reservoir lot.....	1	16	"
Main street, at west line of Prospect street.....	1	16	"
College street, " " " ".....	1	16	"
Prospect street, north of Colchester avenue branch..	1	16	"
Colchester avenue, at east line of Mansfield avenue.	1	14	"
" " at Hospital turn.....	1	12	"
" " at west line of East avenue.....	1	12	"
Pine street, at north line of Howard street.....	1	12	"
" " at south line of Howard street.....	1	12	"
" " at north line of Lakeside avenue.....	1	12	"
" " at south line of Lakeside avenue.....	1	12	"
Colchester avenue, at east line of East avenue.....	1	10	"
" " near Green Mount Cemetery....	1	10	"
Main street, west of Prospect street.....	1	10	"
Main street, at east line of Battery street.....	1	10	"
Battery street, at north line of Main street.....	1	10	"

Battery street, at south line of Main street.....	1	10	inch.
“ “ at north line of King street.....	1	10	“
“ “ at south line of King street.....	1	10	“
“ “ at north line of Maple street.....	1	10	“
North avenue, at south line of North Bend street....	1	10	“
“ “ at north line of North Bend street....	1	10	“
“ “ near Providence Orphan Asylum....	1	10	“
Shelburne street, at north line of Park avenue.....	1	10	“
“ “ at south line of Ledge road.....	1	10	“
“ “ at junction with So. Willard street.	1	10	“
Pine street, north of Howard street.....	1	8	“
Howard street, at east line of Pine street.....	1	8	“
Lakeside avenue, at west line of Pine street.....	1	8	“
St. Paul street, at junction with So. Union street....	1	8	“
East avenue, at south line of Colchester avenue....	1	6	“
Shelburne street, at south line of Park avenue.....	1	6	“
North avenue, at Lake View Cemetery.....	1	6	“
Strong street, at east line of North avenue.....	1	6	“
Ward street, “ “ “ “	1	6	“
North Bend, “ “ “ “	1	6	“
Main street, west of Battery street.....	1	6	“
Lyman avenue, at east line of Briggs street.....	1	6	“
“ “ 365 feet east of Briggs street.....	1	6	“
Barrett street, at east line of Colchester avenue....	1	6	“
“ “ at west line of Chase street.....	1	6	“
Chase street, at south line of Barrett street.....	1	6	“
Murray street, at north line of Allen street.....	1	6	“
“ “ at south line of Allen street.....	1	6	“
Allen street, at west line of Elmwood avenue.....	1	6	“
“ “ at east line of Murray street.....	1	6	“
Loomis street, at west line of Prospect street.....	1	6	“
Hydrant branch, corner of Howard and Pine streets.	1	6	“

Hydrant branch, at intersection of Willard & Union streets.....	1	6	inch.
“ “ on Colchester, at Mansfield ave....	1	6	“
“ “ “ “ “ Hospital turn....	1	6	“
“ “ “ “ “ Ira Allen school .	1	6	“
Fire services for Dunham's property, Pine street....	3	6	“
“ “ “ Queen City Cotton Co., Lakeside Av.	1	6	“
“ “ “ Home for Friendless, Shelburne St.	1	4	“
“ “ “ Burlington Woolen Co., Barrett St.	1	4	“
Elevator service for H. W. Allen & Co., Bank street.	1	4	“
“ “ “ N. E. Chamberlin, Bank street.	1	4	“
“ “ “ O. J. Walker Bros., Bank street	1	4	“
“ “ “ Geo A. Hall, So. Winooski Ave.	1	4	“
Hydrant branch, head of Park Ave. on Shelburne St.	1	4	“
“ “ near No. 124 Shelburne street	1	4	“
Shaw's lane, north line of College street.....	1	4	“
Converse court, at north line of Hickok place.....	1	4	“
Hickok place, at east line of No. Union street.....	1	4	“
Buell street, at east line of south Willard street....	1	4	“
Summit street, at south line of Maple street.....	1	4	“
So. Champlain street, at west line of Main street....	1	4	“
Haswell street, at west line of North avenue	1	4	“
Convent square, at east line of North avenue.....	1	4	“
Crowley street, at east line of North avenue.....	1	4	“
Blow off in Englesby ravine, Shelburne street.....	1	4	“
<hr/>			
Total added.....	79		
Total now in use.....	448		

Repairs for the year have been :

On cement pipe.....	13	breaks.
On cement pipe	10	joint leaks.
On iron pipe	10	joint leaks.

On iron pipe.....	1 split pipe.
On service pipe.....	24 leaks.
On broken hydrants.....	20
On broken gates.....	2

INTAKE.

The intake conduit, of coated cast iron pipe 24 inches in diameter and over two miles in length, was laid in 75-foot sections connected under water by means of the Falcon ball joint.

This joint is made of a ball cast of such diameter, larger than the pipe in which it is to be used, as to admit of obtaining the desired deflection without obstructing the water way, a flanged spherical ring of about three-eighths inch greater radius than the ball and of such width that the ball cannot pass through it, which two parts are leaded together and attached to one end and a flanged bell planed so as to make a tight thimble for the ring, which is attached to the other end of a section to be laid.

The flanged joint made by the diver is rendered tight by means of a thin rubber packing and after laying a short time in our lake water the oxidation which takes place on the planed surface of the ring and thimble makes it doubly so. In a case like that of our intake, where there is no current of constant and high velocity to keep open and increase the size of leaks induced by changes of temperature or settlement, it may safely be expected that such small holes will be closed by oxidation.

The 75-foot lengths of regular bell and spigot pipe were leaded together on shore in the usual manner and before being

taken out by the scow, a flange having been bolted to each end for the purpose, were tested by hydraulic pressure.

The scow was built and work commenced at the station in the winter and before the opening of navigation. The well was sunk, pipe laid from it through the face of the dock and a 24 inch gate placed on the conduit in the well.

By closing this gate and placing a flange on the outer end of the last section laid, it became possible at any time to test the conduit in place in the same manner in which the sections had previously been tested on shore.

The outer or intake end of the conduit is located in about 30 feet of water on Appletree reef. The end being turned up at an angle of ninety degrees and the size of the conduit increased at the bend to 30 inches.

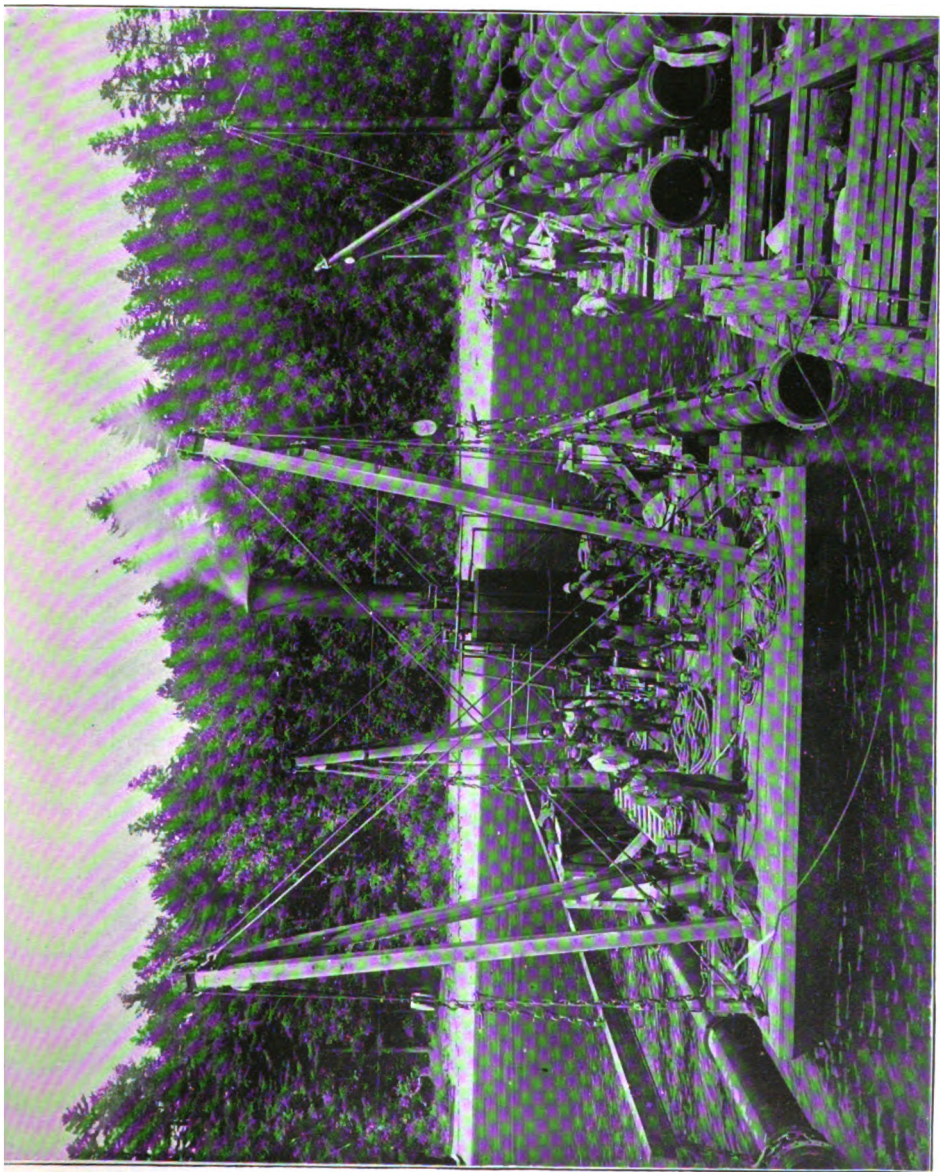
The highest point of the copper screen, which caps the upright, stands about 14 feet below the surface at ordinary low water, and about 5 feet above the oak crib filled with stone which surrounds the upright. By closing a 24 inch gate, located just outside the crib and the one before mentioned in the well at the pumping station, the tightness of the conduit may at any time be easily tested.

The tests which have been made, since the completion and acceptance of the work, have in each case proved the conduit to be tight.

METERS.

There are now in use 1,082 meters, an increase of 206 over last year.

Of the water pumped about 27.89 per cent. has been used through meters, yielding about 52.61 per cent. of the collections.



Ready to start with one hundred and fifty feet of Intake Conduit.

F. R. Menns, Photographer.

Of the water metered, about 21 per cent. has been sold at the 10 cent rate, yielding about 12 per cent. of the meter collections, and about 22 per cent. at the 25 cent rate, yielding about 31 per cent of the meter collections.

Allowing 25 per cent. for leakage and other losses and treating the hydrant rental, which is assessed for protection afforded and not for water used, as a schedule rate receipt, it appears that from about 62 per cent. used at schedule rate only about 48 per cent. of the revenue is derived. In other words, the showing this year is, as it has been for years, that the meter takers, who pay for what they get whether for legitimate use, leaks or waste from other causes and on whom there are no losses, pay decidedly more than their share of the water collections, and this in spite of the fact that over one-fourth of the water metered is sold approximately at cost.

That this should be the case in the face of the recent reduction of meter receipts by the striking out of the highest rate and the increase of the schedule rate receipts, by the increase of the hydrant rental is due to the fact that the meter takers are constantly increasing in number, and that they pay for what they get, whether it be used or wasted.

The receipts from water rates, as shown by the city report, have for years exceeded all current expenditures of the department, interest on the water debt and cost of replacing pipe included.

In view of these facts and of the constantly increasing amount of injustice worked by that feature of our present rates for metered water, which admits at every change of rate of a greater quantity of water being obtained for a less price, or as one of our tax-payers has not inaptly put it "fines the consumer for practising economy," I would recommend

that the following be substituted for the present meter rates, and that the minimum rate be reduced from ten to eight dollars :

For the first 4,000 cubic feet,	20 cents per 100 cubic feet			
From 4,000 to 6,000 c. f. for each additional 100 cubic feet,	15	"	"	"
From 6,000 to 10,000 c. f. for each additional 100 cubic feet,	12	"	"	"
From 10,000 to 20,000 c. f. for each additional 100 cubic feet,	11	"	"	"
Above 20,000 cubic feet for each additional 100 cubic feet,	10	"	"	"

Respectfully submitted,

F. H. CRANDALL, Superintendent.

1894.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.
 Burlington, Chittenden County, Vermont.
 Population by U. S. census, 1890, 14,590.
 Works constructed 1867-8.
 Owned by city.
 Source of supply, Lake Champlain.
 Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel. $\left\{ \begin{array}{l} a \text{ Anthracite.} \\ b \text{ Grate.} \\ c \text{ Pittston.} \\ d \text{ \$5.09 and \$5.95.} \end{array} \right\}$ 47 3-7 weeks.
 g Mill shavings, \$38.50 per week, 4 4-7 weeks.
6. Total pumpage for the year, 336,504,725 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
 Cost of pumping figured on pumping station expenses,
 \$7,940.58.

11. Per million gallons raised against dynamic head into reservoir, \$23.59.
12. Per million gallons raised one foot high (dynamic), \$0.0746.
Cost of pumping figured on total maintenance,
\$43,087.12.
13. Per million gallons raised against dynamic head into reservoir, \$128.04.
14. Per million gallons raised one foot high (dynamic), \$0.405.

FINANCIAL.

MAINTENANCE.

Division I.

RECEIPTS.		DISBURSEMENTS.	
From Consumers.		AA. Management and repairs..	\$31,867.12
A. Water rates, domestic.....	\$33,249 10	BB. Interest on Bonds.....	8,760.00
B. Water rates, manufacturing. 4.975 74		Interest on Notes.....	625.00
From public funds:			
C. Hydrants.....	2,960 00	CC. Total maintenance	\$41,252 12
D. Public Buildings, Fountains and Parks.....	120 00	DD. Balance to the City Treasurer.....	\$ 1,815 87
E.* Watering Troughs \$250 00			
G. Net receipts for water.....	\$41,304 84		
H. Sale of pipes, meters, etc....	1,763 15		
I. Gross receipts.....	\$43,067 99	EE. Total.....	\$43,067 99

*Not paid.

Division II.

From fixed rates.	L. Domestic.....	\$19,472 36
	M. Manufacturing	100 00
	N.....	\$19,572 36
From meter rates.	O. Domestic.....	\$16,856 74
	P. Manufacturing	4,875 74
	Q.....	\$21,732 48
Total		\$41,304 84

CONSTRUCTION.

RECEIPTS.		DISBURSEMENTS.	
T. Appropriations.....	\$73,321 99	FF. Extension of mains.....	\$25,213 32
		GG. Extension of services.....	1,014 92
		HH. Extension of Intake.....	47,093 75
V. Total.....	\$73,321 99	KK. Total.....	\$73,321 99
W. Cost of works to date.....	\$450,092 88		
X. Bonded debt at date.....	248,000 00		
Y. *Value of sinking fund at this date.....	132,841 03		
Z. Rate of interest, four per cent.			

*Toward paying the entire bonded debt of the city,
\$527,000.00.

CONSUMPTION.

1. Estimated total population at date, 15,700.
2. " " " on lines of pipe, 15,700
3. " " " supplied, 15,100.
4. Total number of gallons consumed for year, 336,504,725.
5. Passed through domestic meters, 63,535,928, or 18.88 per cent.
6. Passed through manufacturing meters, 30,319,072 gallons, or 9.01 per cent.
7. Average daily consumption, 921,930 gallons.
8. Gallons per day to each inhabitant, 60.
9. Gallons per day to each consumer, 61.
10. Gallons per day to each tap, 325.

DISTRIBUTION.

MAIN.

1. Kind of pipe, cement lined, cast iron, wrought iron.
2. Size, from four to 24 inches.
3. Extended 8,580 feet.
4. Discontinued, 7,352 feet.
5. Total now in use, 34.91 miles.
6. Cost of repairs per mile, \$18.31.
7. Leaks per mile, 1.0.
8. Small distribution pipe less than 4 inch, total length, 14,500 feet.
9. Hydrants added, 12.
10. Number now in use, 187.
11. Stop gates added, 65.
12. Number now in use, 448.
13. Small stop gates less than 4 inch, total 59.
14. Number of blow-off gates, 10.
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.

SERVICES.

16. Galvanized iron, lead.
17. From $\frac{1}{2}$ to 6 inches.
18. 2,794 feet.
19. 56 feet.
20. 15.8 miles, or 80,859 feet.
21. Service taps added, 98.
22. Number now in use, 2,835.
23. Average length of service, 28 feet.
24. Average cost of service, \$10.00.
25. Meters added, 206.
26. Number now in use, 1,082.
 - a. domestic, - 1,003.
 - b. manufacturing, 75.
27. Motors and elevators added, 9.
28. Number now in use, 26.

STORAGE.

Earthwork reservoirs, low service, capacity, 7,000,000 gallons. Iron tank, high service, capacity, 169,617 gallons.

TWENTY-NINTH
ANNUAL REPORT
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.
DECEMBER 31, 1895.

BURLINGTON
FREE PRESS ASSOCIATION
PRINTERS AND BINDERS
1896

TWENTY-NINTH
ANNUAL REPORT
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.
DECEMBER 31, 1895.

Compliments of

F. H. Crandall, Supt.

Please exchange.

TWENTY-NINTH
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SEVENTH ANNUAL REPORT
OF THE
Water Commissioners.

To the Honorable Board of Aldermen City of Burlington :

GENTLEMEN :—In compliance with the city ordinance the Water Commissioners respectfully submit the following, their report for the year ending December 31st, 1895 :

Notwithstanding the fact that work which seemed of the greatest importance has been postponed, the season has still been quite a busy one in this department.

We still have no adequate means for speedily obtaining large quantities of water from the new reservoir, the cement mains on Main street and North avenue are yet with us and the first steps towards securing our needs at the pumping station, which in our last annual report it was stated had been taken, are still in progress.

The new mains laid last year for the purpose of increasing the supply for Colchester avenue and the First Ward have been connected with the reservoir and the other mains in the reservoir yard in such manner that their supply can be obtained from either of the reservoirs, either through or around the motor, as may be desired. In making these connections it was found advisable to replace about three hundred feet of cement pipe in and near the reservoir lot.

Provision has been made for placing a larger motor on the new line where it passes through the addition to the reservoir lot recently purchased by the city, also for connecting a branch from the new reservoir.

This branch from the new reservoir should be laid at once as it has already been demonstrated that the present main leading from that reservoir is inadequate to meet the demands at times made upon it.

The work which we recommended to be done on College street, Main street and North avenue is no less necessary now than last spring, and the experience of the past season has been sufficient to convince any one of the wisdom of our recommendations. The cost of repairs on Main street alone during the past season has been in excess of four hundred dollars.

Before the changes in pumping machinery, which must inevitably come in the near future, can be made, considerable money must be expended in preparation. This preparatory work should be continued from year to year until at the time of the installation of new machinery all will be in readiness for the event.

The pumpage for the year is twelve million gallons less than last year, in spite of the fact that the record for February, 1895, shows an increase of thirteen million gallons over that of last year. The large decrease may be attributed to the more than usual increase in the use of meters and to the fact that several constant sources of waste have been discovered and discontinued.

The balance turned in to the City Treasury this year more nearly approximates a reasonable and proper excess of receipts

over current expenses of the department than for a number of years previous. This result is brought about by the combined influence of the reduction of receipts, caused by the change of rates, and the increase of current expenses both in the maintenance and interest accounts. We are of the opinion that large sums raised by water assessments cannot be legally and properly used for other purposes.

Whether our opinion be correct or not, so long as there remains so much absolutely necessary to be done to maintain the efficiency of the works, there would seem to be no doubt as to the propriety of appropriating for the current expenses of the water department, interest being included, the entire water receipts, and we would recommend that this be done.

Respectfully,

WM. E. HALL,	}	Water Commissioners.
J. E. LANOU,		
GEO. D. WRIGHT,		

TWENTY-NINTH ANNUAL REPORT

OF THE

Superintendent of Water Works.

*To the Honorable the Board of Water Commissioners of the
City of Burlington, Vt:*

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31st, 1895 :

FUNDS AVAILABLE FOR THE USE OF THE WATER DEPARTMENT.

Balance from 1894, general account.....\$	77	
Balance from 1894, Colchester avenue and Pine St. extension account	1,741 19	
Sale of pipe, meters, etc,.....	3,161 57	
Appropriations.....	36,200 00	
	<u>\$41,103 53</u>	
Less balance returned to City Treasurer.	77	
	<u> </u>	\$41,102 76

RECEIPTS FROM CITY TREASURER.

For general purposes.....	\$39,360 21	
For Colchester avenue and Pine street extension.....	1,741 19	
	<u> </u>	\$41,101 40
Unexpended balance to City Treasurer.....		<u>\$1 36</u>

DISBURSEMENTS.

COLCHESTER AVENUE AND PINE STREET EXTENSION.

Pay rolls.....	\$1,517 11	
Supplies.....	105 09	
Repairing of tools.....	90 00	
Cartage.....	28 99	
		\$1,741 19

GENERAL WATER WORKS ACCOUNTS.

Construction:

Cast iron pipe.....	\$2,160 37	
Labor on mains.....	1,061 27	
Labor on services.....	731 94	
Gates and boxes	411 85	
Lead and yarn.....	206 00	
Material for services.....	165 35	
Hydrants.....	120 00	
		\$4,856 78

Current:

Pay rolls, general work.....	\$2,677 07	
work for individuals.....	950 85	
work on reservoir banks and grounds.....	369 40	
work on ditches dug after close of season of 1894.....	346 65	
work on Main street bursts...	385 35	
work on other leaks and bursts,	574 35	
Superintendent, salary one year.....	1,000 00	
Plumbers' bills.....	551 99	
Keeping 3 horses, shoeing, repairs, etc...	537 77	
Material for management and repairs...	515 26	
Miss Minnie S. Moore, salary one year...	400 00	
Gate and stop boxes.....	350 33	

Repair of hydrants.....	336 36
Water Commissioners' salaries one year..	300 00
Iron watering troughs.....	265 67
Fire hydrants.....	250 00
Supply pipe and fittings.....	234 86
Office expenses.....	228 06
Freight and express charges.....	214 54
Repairs after fire.....	214 01
Repair of tools.....	207 76
Machinists' bills.....	192 24
Printing, advertising and postage.....	189 13
Bills for labor.....	174 77
Reservoir repairs.....	168 05
Coal.....	160 74
Street sprinkling stand pipes.....	146 76
Recording pressure gauges.....	141 60
Hardware.....	132 27
Damages on account cement pipe bursts,	118 03
Paint, oil, brushes, etc.....	96 58'
Telephone rental.....	85 34
Lumber.....	75 56
Oil.....	40 59
Cement.....	40 35
Sanitary examination of water.....	34 00
Street sprinkling assessment.....	6 30
Replacing cement and small iron pipe :	
Cast-iron pipe.....	\$3,556 52
Labor.....	1,975 21'
Lead and yarn.....	783 54
Gates.....	816 10
	<hr/> \$7,131 37
	<hr/> \$19,843 96

Pumping :

Fuel.....	\$6,010 27	
Pay rolls.....	2,200 05	
Repairs to machinery.....	279 93	
Supplies.....	237 99	
Repairs to motor.....	130 83	
Repairs to building and grounds.....	108 47	
Fuel and light at motor house.....	47 40	
		<u>\$9,014 94</u>

Meters :

Meters.....	\$4,680 99	
Pay rolls.....	814 50	
Repairs and freight.....	149 04	
		<u>\$5,644 53</u>

RECAPITULATION.

Colchester avenue and Pine street extension.....	\$ 1,741 19	
Construction.....	4,856 78	
Current.....	19,843 96	
Pumping.....	9,014 94	
Meters.....	5,644 53	
		<u>\$41,101 40</u>

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates.....	\$19,887 25	
Meter rates.....	28,125 14	
		<u>\$48,012 39</u>

DISBURSEMENTS.

Paid L. C. Grant, City Treasurer.....	\$48,012 39
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We hereby certify that we have examined the vouchers and accounts of F. H. Crandall, Superintendent of the City

Water Works, from January 1st to December 31st, 1895, and find the same correct.

GEO. W. BECKWITH, }
JOHN C. FARRAR, } Auditors.
CHAS. B. GRAY, }

FINANCIAL STATEMENT.

ASSESSMENTS :		EXPENSES :	
PAID.			
Water rates, meter.....	\$26,863 89	Management and repairs.....	\$12,712 59
Water rates, schedule.....	15,649 12	Replacing.....	7,131 37
Material and labor.....	3,161 57	Pumping.....	9,014 94
	\$45,674 58	Meter.....	5,644 33
		Interest.....	11,375 00
UNPAID.		Total maintenance.....	\$45,878 43
Meters.....	\$ 1,405 91	Excess of assessments over ex-	
Schedule.....	468 31	penditures.....	1,668 37
	\$47,546 80		\$47,546 80

The total receipts of the year include bills of 1894 to the amount of \$5,499.38, making the excess actually turned into the City Treasury over and above current expenses, interest included, \$5,295.53.

WATER PUMPED.

	1893. Gallons.	1894. Gallons.	1895. Gallons.
January.....	30,331,900	23,958,675	25,338,800
February.....	26,833,000	21,953,825	35,231,175
March.....	27,705,625	23,776,750	24,778,725
April.....	27,479,700	25,981,300	21,938,100
May.....	26,238,550	27,271,475	28,209,475
June.....	35,525,900	33,628,700	33,327,350
July.....	32,414,225	32,300,600	32,414,925
August.....	24,274,475	32,496,775	27,411,450
September.....	30,066,300	32,499,925	26,287,975
October.....	26,526,675	28,856,050	26,795,525
November.....	20,761,400	24,083,050	20,693,400
December.....	29,335,600	29,697,600	21,731,675
Total.....	337,493,350	336,504,725	324,158,575
Decrease.....		988,625	12,346,150
Daily average.....	924,639	921,930	888,105

SERVICES.

There have been added 136 services of the following sizes :

Two.....	6	inch
Two.....	4	"
One.....	3	"
One.....	2	"
One.....	1½	"
One.....	1¼	"
Three.....	1	"
Eleven.....	¾	"
One hundred and fourteen.....	½	"

Two services have been discontinued.

HYDRANTS.

Nine Lang post hydrants, located as follows, have been set during the past season :

Main street west of motor house.

Pearl street corner Clarke street.

North Willard street corner of North street.

Lakeside avenue east of Central Vermont railroad tracks.

Central at Wright avenue.

College corner Prospect street.

Lake street north of Booth's retail shed.

On lake front south of Crane's mill.

Colchester avenue at Chase street.

Of the above one, a steamer nozzle on the College street low service main at Prospect street, replaces a post hydrant formerly attached to the high service main at the same street intersection. The Lake street hydrant replaces a private ground hydrant and the last two replace public underground hydrants.

Private post hydrants have been added to the service on the premises of the Queen City Cotton company, Lakeside avenue, at the expense of the Queen City Cotton company.

Two private post hydrants east of the Dunham mill have become public property by the extension of Pine street.

Two private ground hydrants and one post hydrant on the premises of J. R. Booth, Lake street, have been replaced by two post hydrants, and four private ground hydrants in the north yard have been discontinued.

Total number of public hydrants.....	168
Total number of private hydrants.....	27
Total.....	195

SMALL SUPPLY PIPE.

Three hundred and forty-eight feet of small distribution pipe have been added to the system; 248 on Hungerford terrace and 100 feet on Chase street. One hundred and twenty-nine feet have been discontinued on Mechanics' lane and Russell streets. Total length now in use 14,719 feet.

MAINS.

New mains have been laid on the following streets :

WITH EIGHT-INCH CAST-IRON PIPE.

Lakeside avenue from dead end westerly..... 820 feet.

WITH SIX-INCH CAST-IRON PIPE.

Conger avenue from Lakeside avenue southerly.....	420	"
Central avenue from " " ".....	460	"
Wright avenue from Central avenue westerly.....	130	"
North Willard from Loomis street northerly.....	400	"
Weston street from Henry to Loomis street.....	330	"
Archibald street from Hyde to North Willard street..	115	"
Henry street from North Willard street easterly....	614	"
Church street from Main to Maple street.....	385	"
North Willard from Archibald street main southerly,	35	"

WITH FOUR-INCH CAST-IRON PIPE.

South Union street between College and Buell streets
 northerly from dead end..... 80 feet.

Total length of new mains.....3,789 feet.

Smaller cast-iron pipe has been replaced in the following streets :

WITH TEN-INCH CAST-IRON PIPE.

Pearl street from west line of Church street easterly, 160 feet.

WITH EIGHT-INCH CAST-IRON PIPE.

Church street from Pearl street southerly..... 14 "

WITH SIX-INCH CAST-IRON PIPE.

North Willard street from North street southerly... 250 "

Church street from Main to King street.... 400 "

Total..... 824 feet.

Small distribution pipe has been replaced in the following streets :

WITH FOUR-INCH CAST-IRON PIPE.

Mechanics' lane from east line of Church street
 easterly..... 94 feet.

Russell street from North street main northerly 35 "

Total..... 129 "

The cement pipe in the following streets has been replaced during the past season with cast-iron pipe :

SIXTEEN-INCH.

College street from west line of Prospect street
 westerly..... 40 feet.

TEN-INCH.

Main street from motor house westerly.....	231	feet.
North street from Russell street easterly.....	294	"

EIGHT-INCH.

Colchester avenue from Chase street southerly.....	690	"
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SIX-INCH.

Colchester avenue from Chase street northerly.....	680	"
Chase street from Colchester avenue easterly.....	540	"

FOUR-INCH.

So. Willard street between Maple and Main streets..	216	"
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Total.....2,691 feet.

Total length of pipe replaced, 3,644 feet.

LENGTH OF PIPE NOW IN USE.

Cement.....	65,503	feet.
Iron.....	122,732	"

Total feet of pipe.....188,235

Total miles of pipe.....35.65

GATES.

The following gates have been discontinued :

Church street, south side of Main street main.....	1	4	inch.
Chase street, at Colchester avenue.....	1	4	"
King street, at west line of Church street.....	1	4	"
Chase street, near school house.....	1	4	"
Barrett street, at Colchester avenue.....	1	4	"
Colchester avenue, at Chase street.....	1	6	"
North Willard at North street.....	2	4	"
Church street at north line of Cherry.....	1	8	"
Total.....	9		

The following gates have been set during the past season :

On the reservoir lot.....	2	10	inch.
Pearl street, east line of Church.....	1	10	"
North street, east line of North Willard.....	1	10	"
" " west " " " " 	1	10	"
College street, at Prospect.....	1	10	"
Church street, north line of Cherry.....	1	8	"
Lakeside avenue, at cotton mill.....	1	8	"
" " west line of Conger avenue...	1	8	"
" " west line of Central avenue...	1	8	"
Colchester avenue, at Chase street.....	1	8	"
Conger avenue, at south line of Lakeside avenue ..	1	6	"
" " Wright " " 	1	6	"
" north " " " " 	1	6	"
Central avenue, at south line of Lakeside avenue..	1	6	"
Wright avenue, at west line of Central avenue	1	6	"
College street, at corner of Prospect street, on hy-			
drant branch.....	1	6	"
Lakeside avenue, near cotton mill, on hydrant			
branch.....	1	6	"
Pearl, at Clarke street, on hydrant branch.....	1	6	"
Reservoir lot, on hydrant branch.....	1	6	"
Colchester avenue, at Barrett street, on hydrant			
branch.....	1	6	"
North Willard, at North street, on hydrant branch,	1	6	"
Church street, south line of Main street.....	1	6	"
" " King " " 	1	6	"
" " Maple " " 	1	6	"
" north " " " " 	1	6	"
" " King " " 	1	6	"
King street, east line of Church street.....	1	6	"
" west " " " " 	1	6	"

Colchester avenue, on south line of Barrett street...	1	6 inch.
“ “ at Chase street.....	3	6 “
Archibald street, at east line of Hyde street.....	1	6 “
North Willard street, at north line of Loomis street,	1	6 “
“ “ south line of North street.	1	6 “
“ “ north “ “ “ ..	1	6 “
Henry street, at east line of North Willard street...	1	6 “
“ “ Weston street.....	1	6 “
Weston street, at south line of Henry street.....	1	6 “
“ north line of Loomis street.....	1	6 “
Main street, on fire service of Wells, Richardson Co.....	1	6 “
Battery street, on fire service of J. R. Booth.....	1	6 “
Lake street, on fire service for J. R. Booth.....	1	6 “
College street, on fire service for Merchants' Na- tional Bank.....	1	4 “
Russell street, north line of North street.....	1	4 “
North street, at North Willard street.....	1	4 “
Total added.....	47	
Total now in use.....	486	

The repairs for the year have been :

On cement pipe.....	27 breaks.
On cement pipe.....	11 leaks.
On iron pipe.....	13 joint leaks.
On iron pipe.....	3 broken pipes.
On service pipes.....	25
On broken hydrants.....	33
On broken gates.....	7

METERS.

There are now in use 1,261 meters, an increase of 179 over last year.

Of the water pumped, about 36.9 per cent. has been used through meters, yielding about 61.05 of the assessments.

The statement made last year that "Allowing 25 per cent. for leakage and other losses and treating the hydrant rental, which is assessed for protection afforded and not for water used, as a schedule rate receipt, it appears that from about 62 per cent. used at schedule rate only about 48 per cent. of the revenue is derived. In other words, the showing this year is, as it has been for years, that the meter takers, who pay for what they get whether for legitimate use, leaks or waste from other causes, and on whom there are no losses, pay decidedly more than their share of the water collections," can this year be repeated, except that the percentage of water sold at schedule rates has decreased from 62 to 50, and the percentage of the schedule rate assessments to assessments for water, has dropped from 48 to 39.

That the increase during the past season of the number of meters in use, is slightly less than from the experience of the past few years might have been expected, is not due to the lack of desire on the part of our citizens to adopt the meter system. Owing to the insufficiency of the appropriation, beside being obliged to postpone some work in pipe-laying, which it is thought should have been done during the past season, the department has been reluctantly compelled to refuse a large number of applications for meters.

RATES.

The new rates have now been in effect six months, and it is evident that no great change in the amount of the annual collections will result from the change. While there is still some fault found with the water rates, principally confined to

those on whose premises large quantities of water have been wasted, there is now, under no circumstances, a premium offered for the waste of water. The new rates have accomplished the purpose for which they are particularly intended and are giving general satisfaction.

Appended to this report will be found the Rules, Regulations and Rates of the department, a summary of statistics suggested by the New England Water Works Association and an interesting paper by Prof. Wm. T. Sedgwick of the Massachusetts Institute of Technology, on the sanitary condition past and present of the water supply of the City of Burlington, Vt. Prof. Sedgwick has for a number of years, both prior to and since his careful investigation of the subject in 1892 at the request of the water department, devoted more or less time to the examination biologically of the condition of the city's water supply.

In the consideration of his subject, a threadbare one in this region, the Professor deals to a considerable extent with facts as dry as stubborn, which by no known means can be given in print the living interest with which they were clothed at the time of their presentation at the September meeting of the New England Water Works Association in Burlington. To the favored few Burlingtonians who were able to listen to the address of the Professor, the printed report will furnish an aid to the digestion of the subject, and to all interested whether locally or as students the summary of facts and deductions from the same cannot fail to be deeply interesting.

Respectfully submitted,

F. H. CRANDALL,
Superintendent.

ON THE SANITARY CONDITION, PAST AND PRESENT,

OF THE

WATER SUPPLY OF BURLINGTON, VT.

By WILLIAM T. SEDGWICK,

*Professor of Biology in the Massachusetts Institute of
Technology, Boston, and Biologist to the State Board
of Health of Massachusetts.*

To the student of hygiene the sanitary history of the water supply of Burlington, Vermont, is peculiarly interesting and instructive. Burlington is the only city in New England which derives its water supply from the same lake into which it empties its sewage, although this arrangement for water supply and sewage disposal is common enough in other parts of the United States. It also affords a notable example of a community which has long used a suspected water without having suffered excessively from typhoid fever while yet exhibiting a condition of widespread and continued diarrhœal disturbance among its inhabitants; a condition which was apparently entirely due to consumption of impure water and has been apparently entirely corrected by simply increasing the distance between the sewer outfall and the water intake in the lake.

The location of Burlington is all that could be desired. Situated at the eastern extremity of Burlington Bay on Lake

Champlain, it occupies a very favorable sanitary position. The city is closely built over a small area only. For the most part it has an open suburban character and rests upon, or at the foot of, a hillside which rises rather abruptly from the lake and leads to an elevated and very extensive terrace or tableland stretching many miles to north and south, as well as eastward to the nearest hills—the higher ranges of the Green Mountains—some eighteen miles away. Built thus upon the rather sharp declivity by which this broad terrace passes into the lake; with the Green Mountains on the east, and on the western horizon the sinuous line of the Adirondack peaks; while at its feet the long lake reflects the shafts of sunlight and tempers the hot breaths of summer, the city has naturally a most fortunate situation. The climate, though cold in winter, is salubrious and the natural drainage excellent.*

Water in superabundance is at hand; and when, in 1866, the citizens determined to have an ample public water supply for fire and other purposes they naturally turned first of all for a source to Lake Champlain. Yet they did not finally decide to use the lake without due deliberation and careful inquiry.

"In 1866, when the matter of building our water works was under discussion, a gravity supply from Brown's River,

*"Nature has done much to render Burlington both beautiful and healthful. It is unsurpassed among the places noted for the beauty of their location and their natural surroundings. Situated in the midst of mountain scenery, and bounded on the west by Lake Champlain, it possesses everything to contribute to good health. Opportunities for health-giving exercise abound, in walks, drives, mountain-climbing and yachting.

* * * *

"The climate is not excelled for salubrity. While the vicinity of the lake modifies the extremes of temperature, both in winter and summer, the atmosphere is unusually bright and clear, and the proportion of sunshiny to cloudy days is about five to one in all seasons of the year."—(*Annual Report of the Health Officer—Dr. H. Crandall—for 1893.*)

in Jericho, was alluded to, and the matter was disposed of in the report in the following words: 'At no distance less than about eleven miles can we obtain a supply of water by gravitation from any place, and as this would involve an expense of about \$500,000 such a mode of obtaining water at this time is out of the question.'"—(*Annual Report of the Water Commissioners of Burlington, Vt.*, for 1889, p. 95.) It was accordingly decided to abandon the idea of a gravity supply and to pump from the lake into the pipes, the surplus going to a reservoir at the top of the hill.

The water works were built in 1867, the intake being located on the lake front near the northern extremity of the docks. They appear to have given at first entire satisfaction. "At no time has the city water supply held so high a place in the public estimation."—(*Sixth Annual Report of the City of Burlington*, for 1870, p. 122.) As early as 1871, however, attention was drawn by the Health Officer (Dr. H. A. Crandall,) to the desirability of extending the intake further into the lake. "The prospect of increased sewerage, the increased shipping about the docks, and the great amount of surface water flowing into the lake from our streets, besides other important reasons, influence me to recommend an extension of the pumping main at the pump house of the water works farther into the lake, say 300 feet or more, to deep and pure water."—(*Seventh Annual Report*, for 1871, p. 85.)

The occurrence of 5 deaths from dysentery and 3 from diarrhoea in 1870, and of 10 from dysentery in 1871, suggest that the "other important reasons" referred to by Dr. Crandall may have been the prevalence of diarrhoeal disturbances. However this may be, the Health Officer for 1874 (Dr. A. P. Grinnell,) appears to refer to such a condition in his annual

report for that year, and to have been moved to make an investigation. "It is generally believed that the water obtained from the lake is chemically pure and wholesome; but the prevalence of a certain class of disease whose origin could be traced to impure water or food has led me to make a more thorough investigation of the matter, and now I am able to place before the Board [the city council] the results of experiments, and the conclusions at which I have arrived, respecting the impurity of the water supplied to the people of this city." —(*Tenth Annual Report*, for 1874, p. 76.) The Health Officer then gives the results of chemical analysis of the water of the lake at the intake, one specimen having been collected from the surface and one from near the bottom, and continues: "The amount of organic matter found in either specimen is sufficient to warrant the statement that the water now supplied to the city contains impurities which are capable of generating diseases of a grave character. * * * * We can safely presume that the water consumed by the city is much of the time unfit for use. * * * * The necessity of supplying pure and wholesome water for purposes of drink and diet is apparent to everyone; but it is hardly possible to obtain such supplies from a point in the lake only *sixty feet* from the docks—the natural reservoirs for the excrementitious matter found in sewage." Dr. Grinnell also advised the extension of the intake pipe, "to or beyond the breakwater." (*loc. cit.*) This advice was repeated in the next Annual Report by the Health Officer for 1875 (Dr. C. P. Thayer).

On the other hand, in the *Fourteenth Annual Report*, for 1878, p. 198, the Health Officer (Dr. H. H. Atwater) states: "In my observation of the diseases of this city and their causes during the period from the introduction of the

public water supply to the present time, I have been unable to trace any distinct ill effects from the present source of supply. Typhoid fever, the disease which, of all others, we should expect to result from sewage contamination of drinking water, is of infrequent occurrence in this community. There has been only one death from this disease during the last year, and this of a man over 70 years of age. Diarrhœa and dysentery occur here sporadically, and are not virulent, and prevail mostly during the summer months, so that they may be more reasonably attributable to the debilitating effects of heat, over-exertion and other causes, than to impure drinking water. * * * Still, it seems to me that as the number of public sewers and the amount of sewage flowing directly into the lake yearly increases, it would be wise for the city to consider soon the propriety of obtaining the water at a greater distance from the shore."

In 1882, out of a total of 254, there were eight deaths from typhoid fever and eight from diarrhœa and dysentery, besides three from cholera morbus—a sum of diarrhœal disease which amounted to an epidemic.

In 1883 the Health Officer (Dr. John B. Wheeler) states: "First in the list of improvements, by which the public health would unquestionably be benefitted, is the extension of the water main to some point outside the breakwater. * * * It can hardly be doubted that much of the diarrhœal trouble so common in Burlington is due to the condition of the city's water supply. To extend the water main beyond the breakwater would be to take it beyond the reach of contamination and give our citizens a supply of pure water."—(*Nineteenth Annual Report*, for 1883, p. 88.)

Dr. Wheeler, as Health Officer, in the next annual report,

says : "Some alarm was created, in the early summer, by the appearance of typhoid fever in the city. The alarm was owing not so much to the number of cases, which was not large, as to the existence of the disease, which is almost unknown in Burlington, except when an occasional case is imported. The number of fatal cases in 1884 was 10. * * * The character of our water supply has been the subject of a good deal of discussion during the past year."—(*Twentieth Annual Report*, for 1884, pp. 55, 56.)

In 1885, the Mayor of Burlington, in his annual *Message*, said : "The subject of a supply of purer water for our city has been much discussed, and opinions are various among our citizens. * * Several analyses of water taken from different parts of the lake — and from other waters than the lake — have been made by competent chemists, and they indicate that we should not be materially benefited by changing the present source of supply. Whether analyses should be taken as conclusive evidence of fitness or unfitness of water for human use I am not prepared to say, but common sense would teach that, other conditions being equal, the greater the distance water is taken from a source of infection, the purer it will be." In the same report (*Twenty-first Annual Report*, for 1885) the Health Officer, Dr. J. H. Linsley, remarks : "The fact that no case of typhoid fever was reported to the Health Officer during the year refutes the possibility of the cause of the appearance of this disease in 1884, being in our water supply, as was at that time suggested."

During 1884 and 1885 numerous chemical analyses were made and in the Mayor's message, delivered on April 5, 1886, we find the following conclusion based upon them : "Some two years since the water committee were directed to examine

into the subject of our water supply, and to report the result of their investigations to the board. They have just made their report, which contains the results of many analyses of water taken from various localities in the lake. The report imparts the gratifying assurance that the water at the point from which it is now pumped is as pure, if not purer, than at any other locality in the lake. There are some people who do not appreciate the value of the findings of the committee.”— (*Twenty-second Annual Report*, for 1886, p. 13.) In the same *Report* (p. 74) the Health Officer (Dr. J. H. Linsley) remarks: “More or less discussion is constantly going on in regard to our present water supply, and many views are entertained as regards the comparative purity of the water used. I am unaware that the existence of any disease was ever traced to its impurity. But I think no one will deny that the surroundings of the suction-pipe, as at present situated, are not such as would tend to quiet the misgivings of anyone who is inclined to be skeptical in regard to the purity of the water at our present source of supply. I would respect, fully recommend that when it is seen fit to extend the suction-pipe into the lake, such extension be made far enough to be beyond the *possible* contamination of the sewage from this city. Of course, the construction of the sewer in Battery street removes nearly all the sewage that formerly emptied into the lake at the foot of College street, to a point fully half a mile further south.” Also in the same *Report* (p. 99), the superintendent of water works (Mr. F. H. Parker) states: “By a vote of the Board of Aldermen, May 17th, 1886, the city treasurer was authorized to borrow \$24,000 * * * * for the purpose of * * * * and extending the suction-pipe to the pumps farther into the lake.” * * * * “A city meeting was

called, * * * * but the resolution authorizing the work was dismissed, and the improvements have not been carried out."

For 1888 we find in the report of the Health Officer (Dr. J. C. Rutherford) the following: "There was more sickness during the year just ended than for several years past. * * * * Different types of fever prevailed during the late summer and autumn, some of them taking a typhoidal form. The mortality from them, however, was very low. On December 24 I sent to the physicians of the city a circular letter requesting them to give me, to the best of their knowledge, the number of cases of fever they had attended during the past year. Nearly all replied, and although they said they had no record of their cases, the number they remembered was, in the aggregate, very large. They ascribed the cause of so much sickness to, First—the long-continued wet weather. Second—the sudden changes of temperature; and Third—the unwholesome* condition of the aqueduct water. * * * *

"There have been reported to me twenty-six cases of typhoid fever. The source of only two could be traced from out of town; the rest, beyond any reasonable doubt, originated here. Many other cases were reported as typhoid, which, upon examination, I found to be of another type of fever. * * * *

"The water supply of the city has again become a prominent topic of conversation. Owing to the great amount of sickness during the summer and autumn, people have begun to question the purity of the aqueduct water."—(*Twenty-fourth Annual Report*, for 1888, pp. 74-77.) In the same

*The same increase in fevers was noticed in St. Albans, Swanton and surrounding towns.

document Mr. F. H. Crandall, who began his service as superintendent on April 25, 1888, (succeeding Mr. Parker, who became chairman of the newly-established water commission,) in making his first report, says (p. 131): "The unusual amount of sickness in our city for some time past has again called public attention to the purity of our water supply. Various plans for its improvement have, for some time past, been under consideration, * * * * and investigations are now in progress as to the relative merits of different sources of supply."

The results of the "investigations" here referred to appeared in the next report (*Twenty-fifth Annual Report of the City of Burlington, Vt.*, for 1889, pp. 95, 105, 113. See also *Twenty-third Annual Report of the Water Department, City of Burlington, Vt.*) and consisted mainly of a report of progress. The documents referred to are duplicates, and include statements from the commissioners and superintendent, and a lengthy and interesting summary of the situation from the chemical standpoint by Mr. Joseph L. Hills, chemist of the State Agricultural Experiment Station of Vermont. From Mr. Hill's report is taken the table of analyses given on the next page.

Chemical Analyses of the Water Supply, Etc., of Burlington, Vt., Previous to May, 1889. [Compiled by Joseph L. Hills.]									
Source of Sample.	Date.	Analysis By	Free Am.	Alb. Am.	Total Solids.	Fixed Solids.	Volatile Solids.	Chlorine.	Parts Per Million.
Hydrant.	1882	Mallet	0.035	0.14	70	20	50	0.7	
Service Supply, Elmwood Avenue.	Sept., 1884	Sabin	0.04	0.16	164	--	--	--	
Mouth of Suction Pipe, Pumping Station	"	Sabin	0.16	0.16	36	--	--	--	
"	"	Withhaus	0.052	0.13	72	--	--	2.1	
"	March, 1885	Withhaus	0.034	0.10	89	--	--	1.1	
"	"	W. R. Nichols	0.02	0.15	71	57	14	0.2	
"	"	Seeley	--	--	60	41	19	--	
"	Jan. 8, 1889	Hills	0.08	0.18	88.5	54.5	34	1.7	
Northwest corner of Breakwater, 10 feet deep.	Sept., 1884	Sabin	0.06	0.114	119	--	--	--	
"	"	Withhaus	0.026	0.11	84	--	--	1.5	
"	March, 1885	Withhaus	0.016	0.08	75	--	--	1.1	
"	"	W. R. Nichols	trace	0.08	73	60	18	2.0	
Foot of Bank Street.	Jan. 8, 1889	Hills	0.02	0.19	86	49	87	1.4	
Northwest corner of Breakwater, 26 feet deep.	Sept., 1884	Withhaus	0.146	0.17	79	--	--	1.8	
"	March, 1885	Withhaus	0.034	0.08	76	--	--	1.0	
"	"	W. R. Nichols	trace	0.08	70	55	15	1.8	
Marks' Bay, 58 feet deep.	Sept., 1884	Sabin	0.048	0.10	107	--	--	--	
" 63	"	Withhaus	0.08	0.10	56	--	--	5.8	
"	March, 1885	Withhaus	0.034	0.05	66	--	--	0.9	
Surface, midway Sewer mouth to South end Breakwater	Jan. 8, 1889	Hills	0.03	0.16	80	45	85	2.9	
"	Sept., 1884	Sabin	0.04	0.072	100	--	--	--	
"	"	Withhaus	0.08	0.13	116	--	--	9.7	
Three thousand feet west of Pumping Station.	March, 1885	Seeley	--	--	69	52	17	--	
Rock Point.	"	Seeley	--	--	61	44	17	--	
Reservoir Water, 48 hours pumped.	Sept., 1884	Sabin	0.093	0.168	129	--	--	--	
Reservoir Water, (Old Reservoir)	Dec. 29, 1888	Hills	0.03	0.16	80	45	85	2.9	
"	"	Hills	0.03	0.18	88.5	54.5	84	4.8	
"	"	Hills	0.04	0.14	--	--	--	2.4	
Hinesburgh Pond	Feb. 12, 1889	Hills	0.06	0.20	63	50	18	2.6	
"	March, 1885	W. R. Nichols	0.06	0.20	53	38	20	--	
"	"	Seeley	--	--	53	38	20	--	
"	Feb. 13, 1889	Hills	0.04	0.15	93	43	50	3.7	

Mr. Hills himself added to this list twenty-three more chemical analyses, made at the Experiment Station between May and November, 1889, from the city service, various points in Lake Champlain, and several places from which it had been proposed to obtain a gravity supply.

From his several investigations Mr. Hills concluded that "The testimony of chemical analysis would appear to be, so far as one year's experience can indicate, that all the [proposed] sources of supply are of medium purity, except perhaps, Hinesburgh Pond. * * * * The station chemists have not been able to detect evidences of sewage in samples from Mark's Bay or the pumping station (or indeed in a series of samples taken about one hundred yards away from the sewer mouth in the endeavor to trace the direction of sewage currents.) * * * * One of the most interesting points * * * * is that the water from the broad lake does not appear purer than that taken inshore. * * * * It does not appear settled that the extension of the suction-pipe will of necessity give our community a purer water supply."

Reviewing all the facts and data observed or collected up to this time, the superintendent (Mr. Crandall) wisely and truthfully remarked in his annual report for 1889, that they "afford a subject for careful thought and study, as well as a chance for interesting comparisons."

In 1890 the Health Officer (Dr. J. C. Rutherford) reported that "During the present winter there has been in the city a mild epidemic of diarrhoea, which some people supposed was caused by impure water. A meeting of the State Board of Health was called in this city, at which several of the prominent physicians gave their testimony, and the majority of them

were of the opinion that the sickness was caused more by the variable weather than by the water. Anyone who doubts the purity of our water would be convinced that it is pure if he will take the trouble to visit the pumping station and the reservoirs."—(*Twenty-sixth Annual Report* for 1890, p. 73.)

In spite of this "mild epidemic" of diarrhoea," no death from this cause is reported for either 1890 or 1891. Two deaths were reported in 1890 from dysentery, and one each from typhoid, continued, and two from typho-malarial fever.

The total mortality, the typhoid fever mortality, and the percentage which the latter was of the former, for the twenty-six years, 1870–1895, are shown in the following table :

TYPHOID FEVER MORTALITY IN BURLINGTON, VT.
(1870–1895.)

Year.	Total Mortality.	Typhoid Fever Mortality.	Mortality Percentage from Typhoid Fever.
1870	169	2	1.18
1871	146	6	4.10
1872	157	2	1.27
1873	228	--	----
1874	152	--	----
1875	144	--	----
1876	148	2	1.35
1877	246	4	1.98
1878	183	1	0.54
1879	228	2	0.87
1880	219	3	1.37
1881	226	2	0.88
1882	254	8	3.15
1883	242	1	0.41
1884	238	10	4.20
1885	266	1	0.37
1886	262	4	1.53
1887	286	4	1.05
1888	375	9	2.40
1889	248	8	3.14
1890	300	4	1.33
1891	272	4	1.47
1892	336	6	1.77
1893	306	10	3.26
1894	311	2	0.64
1895	311	1	0.32

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MORTALITY FROM TYPHOID FEVER PER 10,000 INHABITANTS IN CENSUS
YEARS.**

Year.	Population.	Deaths from Typhoid Fever.	Deaths from Typhoid Fever per 10,000 Inhabitants
1870.....	*14,387	2	1.8
1880.....	11,864	3	2.6
1890.....	14,590	4	2.7

The general situation when, in 1892, I was invited to make an investigation of the sanitary condition of the water supply appears, from what has thus far been brought together, to have been somewhat as follows :

First. It was widely held by physicians and understood by the people that diarrhoea was common among users of the water, especially those who had not become habituated to it, visitors to Burlington, if they drank the water, frequently suffering from some diarrhoeal disturbance.

Second. The location of the intake of the water works was less than a mile from the outfall of the main sewer, and only a few rods from the docks.

Third. Typhoid fever, the ordinary measure of the sanitary condition of a water supply, was not then, and had seldom been, excessively prevalent in Burlington.

Fourth. Chemical analyses had indicated that the water supply of Burlington was at least the equal in purity of many well-known and excellent water supplies.

Fifth. Chemical analyses had failed to show any marked superiority in the water of the broad lake (the middle of Lake

*Unquestionably incorrect, estimated at 8,750, making deaths per 10,000 2.3 instead of 1.3.

Champlain) to that at the intake on the shore of Burlington Bay.

Sixth. Investigations had proved that it would be difficult, uncertain and costly to procure a gravity supply from the mountains, because of their remoteness, and for other reasons.

It is only fair to add that at the time of my own investigations and of making my report I was less familiar with some of these facts than I am now.

Previous to 1892 the sewer outfall had frequently attracted the consideration of physicians and other citizens. When the water in the lake was low the sewage from the main sewer was not discharged into the lake beneath the surface or even on the lake front, but ran in an open stream over flats laid bare by the receding waters of the lake and emptied into a small bay or basin connecting with the lake. The stench which at times arose from this torpid stream, from the flats and the bay, were highly obnoxious and objectionable, so that a demand had come, especially from the Board of Health and its efficient health officer, Dr. F. H. Crandall, for an improved outfall. Mr. F. P. Stearns, C. E., Engineer-in-Chief of the State Board of Health of Massachusetts was finally consulted, and advised an extension of the outfall to the main lake front with disposal there directly into the lake, and at a depth sufficient to be always below the surface. Incidentally he recommended the extension of the intake of the water works to a point further out in the lake.

I had already been making (in Boston) occasional bacterial analyses of the city water, the lake, etc., for the water commissioners of Burlington, when, on June 20th, 1892, I was invited by them to visit the city and make a thorough in-

vestigation of the sanitary condition of its public water supply, present and prospective. I did as I was desired and subsequently presented a Report, of which the following is the principal portion:—

BOSTON, June 30, 1892.

“To the Board of Water Commissioners, Burlington, Vt.:

GENTLEMEN :—I have the honor to submit to you a report upon my investigations, made at your request, concerning the sanitary condition of the Burlington water supply and the probable sanitary effect of certain proposed changes therein.

“I am informed that many of the physicians regard the water supply with suspicion, and I find that the successive Health Officers in their official reports have frequently referred to the water as more or less objectionable. I therefore undertook, first, to discover the actual effects of the water supply upon the health of the city.

“In order to do this in the case of a water supply suspected of sewage contamination it is customary to take as a measure the prevalence of diarrhœal diseases, and especially typhoid fever. I have therefore carefully studied the vital statistics of Burlington for the last twelve (12) years, comparing the mortality from typhoid fever with the total mortality and also with the number of inhabitants.

The results show conclusively that the mortality from typhoid fever (and the same is true for diarrhœa and dysentery) has not been large in Burlington during the last twelve years. The average annual mortality from typhoid fever, from 1870 to 1891 in Burlington was 3.57 per 10,000 inhabitants.”

I then went on to show that Burlington compared favorably in this respect with many cities having water supplies of

undoubted purity, and stated that in respect to mortality from typhoid fever it had a better record than "many cities having water supplies of good reputation. This weighty fact alone justifies the conclusion that there is no positive evidence in the sanitary statistics of the city that the water supply is injurious to the public health. I may add by way of confirmation that during the last three years I have made repeatedly bacteriological analysis of the Burlington supply, and that I have found no satisfactory evidence of the presence of sewage in the drinking water.

"It is interesting and instructive to compare the history of typhoid fever in Burlington during the last six (6) years with that during the earlier half of the period under consideration, for in this way we may learn whether the disease is or is not increasing. If we do this we obtain the following results :—

TYPHOID FEVER* IN BURLINGTON, VT.

Six-year Periods.	Average Annual Death Rate from Typhoid Fever per 10,000 Inhabitants.	Average Annual Mortality Percentage from Typhoid Fever.
1880-1885	3.39	1.73
1886-1891	3.75	1.88

These figures are certainly reassuring, and prove conclusively that there is no immediate reason for excessive anxiety or alarm for the sanitary condition of the water supply.

"It is, however, the opinion of many Burlington physicians, based upon their experience that the water supply is

* Including "enteric," "slow," "continued," and typho-malarial" fevers.

responsible for the occurrence from time to time of diarrhœal disturbances which, while they very rarely result in death, serve to annoy and alarm the citizens. In the present state of our knowledge it is at present impossible to prove or disprove this theory. The fact appears to be that such disturbances are common, and it is well known that the main sewer of the city empties into Lake Champlain, the source of the water supply, less than a mile from the intake. Whether there is anything more than coincidence in these facts it is impossible to say. In the present state of sanitary science, however, there can be no doubt whatever that the location of the intake of the water-works, as near as it now is to the main sewer of the city, is highly objectionable if not positively dangerous. I can only regard it as a constant menace to the sanitary welfare of the city. It must be admitted as entirely possible that unpurified sewage driven by winds or carried by currents may be in the future, if it has not been in the past, conveyed more or less directly from the sewer outfall to the water intake.

I have, therefore, at your request, considered the probable sanitary advantages of a removal of the intake of the water works to a point in the "broad lake" some three miles from its present position, and also those of a complete change from the lake to a mountain supply.

"In regard to the former—the broad lake supply—I am of the opinion that it would be of very great advantage from a sanitary standpoint, inasmuch as it would so far remove the intake from the sewer outfall as to make it unlikely that raw sewage would ever pass from the latter to the former; while at the same time it would give more time for the purification *en route* of any sewage which might accidentally so pass.

Unless the city should become very much larger than it now is, the passage of sewage from the sewer outfall to an intake located, for example, on Apple-tree Reef, through the present sewer basin and the quiet waters of the bay, can only be regarded as a remote possibility.

"I may remark in passing that, in my judgment, one reason for the comparative immunity from epidemics of typhoid fever hitherto enjoyed by this city is that the sewage is held in a small bay for a longer or shorter time, according to circumstances, where it can to some extent become freed from the germs of disease.

"If Burlington could draw its water supply by gravity from mountain streams or storage reservoirs and secure abundant water from an unpolluted watershed the danger of infection by the water supply would be done away. So far as I can judge, however, there are no streams of sufficient size and purity directly available. Storage would be an unavoidable necessity. But storage, while of great sanitary advantage so far as the germs of specific diseases are concerned, is apt to lead to disagreeable consequences in other directions. The water drawn from storage reservoirs is often more or less colored by peat, stumps, leaves, etc., and it not infrequently suffers fermentation, with the development of organisms, acquiring thereby disagreeable and sometimes nauseous tastes and odors. If these compel the citizens to abandon its use and lead them to resort to polluted wells or other objectionable sources of supply, the sanitary consequences may be unfortunate. It will be seen, therefore, that while a mountain supply is in many respects highly desirable it is nevertheless true that its adoption in this case would be attended with the possibility of some undesirable consequences. It must be

remembered that every new water supply depending upon the storage of surface water is an experiment. It cannot be undertaken without some risk of undesirable results.

"In fine, I am of the opinion that there is no positive evidence of any injurious characteristics in the present supply. But I believe, nevertheless, that in view of the common occurrence of diarrhoeal disturbances reported by physicians, and on account of the menace to the public health involved in the present arrangement, some other source of supply should be found. I think that it would be of very great sanitary advantage to remove the intake as far as possible out into the broad lake. A mountain supply in storage reservoirs would afford complete relief from sewage contamination, but might involve serious troubles with microscopical organisms, tastes and odors.

"Respectfully submitted,

WILLIAM T. SEDGWICK."

This report was generally accepted as establishing the fact, that while there was no occasion for immediate alarm or excessive anxiety, it was imperative that steps should be taken, as soon as practicable, to improve the situation. The epidemic of 1882, 1884 and 1889 were not forgotten, and the figures submitted by me showed a perceptible, though slight, increase of typhoid fever and diarrhoeal disturbance during the more recent six-year period. Accordingly, after still further deliberation, it was decided to extend the intake-pipe some three miles into the lake to a point known as Apple-tree Reef, which had been found by repeated bacterial analyses to be a favorable one for the purpose. This extension, as has been fully described in the preceding paper by Mr. Crandall,

was made in the summer of 1894. Its completion was undoubtedly hastened by the improved sewerage plan recommended by Mr. Stearns in 1892, and about to be carried out by the Sewer Commissioners, by virtue of which the main sewer outfall would be pushed outward to the lake front, the sewage discharged at all seasons beneath the surface of the lake. As soon as this improvement became assured, Mr. Crandall and the Water Commissioners, as well as the Board of Health, redoubled their activity in urging that the intake of the water supply should be removed further out into the lake, and all the more because the little bay in which at certain seasons the sewage fermented and doubtless worked itself to some extent free from disease germs, was now to be obliterated, so that fresh sewage might at times readily find access to the currents, if any, along the lake front, and at a point less than a mile from the intake of the water works.

I have lately had made by an assistant, Mr. S. C. Prescott, in the laboratory of the Vermont Agricultural Experiment Station—kindly placed at our disposal by Prof. Jones, to whom our hearty thanks are due—a series of careful bacterial analyses of water taken from various points on the high service and the low; at the pumping station; from the pump well; and from the lake just outside—a point which corresponds to the old intake; from the lake front near the sewer outfall; and from the new intake on Apple-tree Reef. These show conclusively, both by comparison with analyses made before the extension of the intake and by comparison one with another, that the removal of the intake to a distant point in the lake has caused a marked bacterial improvement in the purity of the city water.

[These facts were at this point demonstrated to the audience by means of the stereopticon: actual plate "cultures" of equal amounts of water from different parts of the service, from the lake, the sewer outlet, the intake pump well, etc., grown upon gelatin or agar and fixed by formaldehyde, being placed in the lantern and thrown upon the screen. In this way a unique and striking demonstration was afforded of—for example—the progressive and remarkable disappearance of bacteria from the sewer outlet, where they were abundant, to the old intake where they were relatively few, yet far more numerous than at the new intake or at any point in the service pipes.]

Chemical analyses, as far as they go, confirm the bacterial results, as may be seen from the following:—

BURLINGTON, VERMONT, SEPTEMBER 4, 1895.

SANITARY WATER ANALYSIS.

(Parts in 100,000.)

	Residue on Evapora- tion.			Nitrogen.							Oxygen Consumed.	Chlorine.	Hardness.	Iron.	Microscopical Organisms in 100 Cubic Centimeters.		
	Total.	Loss on Ignition.	Fixed.	Albuminoid Ammonia.			Free Ammonia.	As Nitrates.	As Nitrates.								
				In Solution.	In Suspension.	Total.											
Lake (old intake)	6.60	1.25	5.35	.0110	.0028	.0138	.0010	.0000	.0010	.2730	.14	4.2	.0060	3,550	1,400	200	
Tap (city serv.)	6.20	1.05	5.15	.0072	.0048	.0120	.0000	.0000	.0100	.2496	.10	4.2	.0060	1,050	6,200	150	

But there is another kind of evidence which witnesses still more eloquently to the improvement of the water supply,

and this is the testimony of the physicians of Burlington. As far as I have been able to communicate with them—and I have interviewed a number of the most prominent and representative—there is a surprising and remarkable unanimity of opinion among them to the effect that the peculiar diarrhœal disturbances which had for so long prevailed in Burlington have, since the extension of the intake pipe, wholly ceased; and the physicians are enthusiastic in their recognition of the salutary change, which they attribute entirely to the improved water supply.

In view of all the evidence at hand—statistical, bacteriological, chemical and medical—I think we may safely conclude that the sanitary condition of the water supply of Burlington is now most excellent. If, however, in the future Burlington grows extensively and becomes a much larger city it will probably become necessary here, as in most large cities, to face once more the question of a pure water supply. Special pains must also be taken to see to it that the intake pipe is kept intact and free from leakage. The unfortunate experiences of Toronto and of Buffalo with broken intake pipes afford ample warnings in this direction.

This is the first case within my own experience, now somewhat extensive, in which epidemic diarrhœa in a mild form has prevailed in a community for many years having its ætiology in the consumption of impure water, as has been proved by its apparent total disappearance on a change in the source of supply. The importance of the case in the history of water-borne diseases is manifest. It was complicated by the fact that typhoid fever, which is usually taken as a measure of the sanitary condition of a community, was here ordinarily by no means excessive, while its occasional prevalence might easily

have been due to some other cause than polluted water. The fact would seem to be, however, that it was in both really due to impure water, inasmuch as since the extension of the intake pipe in 1894 typhoid fever has practically disappeared. It would seem fair to conclude, from the moderate occurrence of typhoid fever, while diarrhœa abounded, that germs of the latter disease, more hardy than those of the former, were frequently able to survive a journey from the sewer outfall to the water intake while those of typhoid fever, if present at all, usually perished. In future sanitarians will not be able by the test of typhoid fever alone to show that a water supply is entirely above suspicion. A mild form of diarrhœa caused by polluted water may apparently prevail even in the absence of any constant and considerable excess of typhoid fever.

RULES AND REGULATIONS OF THE BURLINGTON CITY WATER WORKS.

Adopted by Resolution, Approved May 8, 1895.

1. Applications for water must be made at the Superintendent's office, and must be signed by the owner of the premises to be supplied or his or her duly authorized agent, and must state the use for which the service is desired.

2. All premises are entitled to a service pipe $\frac{1}{2}$ inch in diameter to the line of streets, at the expense of the city, and larger services will be furnished for fire purposes or where a meter is to be used, on property holders paying the increased cost. Any service hereafter put in larger than one inch in diameter, used for any other than fire purposes, shall, if more than 25 feet in length, be metered within that distance of the street.

3. When two or more take water through one service pipe, the ordinance in regard to cutting off the supply shall be applicable to all, although one or more shall be innocent of any cause of offence.

4. Outside faucets or yard hydrants for the supply of families, not allowed, unless kept in perfect repair.

5. No person shall be entitled to damages, nor to have any portion of a payment refunded, for any stoppage of supply occasioned by accident to any portion of the work, for stoppage for addition or repairs, or for non use occasioned by absence.

6. All persons taking water must keep the fixtures and service pipe within their own premises in good repair and fully protected from frost, and must prevent all unnecessary waste of water, unless supplied through a meter.

7. No charge will be made for water from private hydrants or pipes that may be erected and used for fire purposes only, but any other use of such hydrants or pipes is prohibited except the service be metered as required by sections 2 and 11 of these rules.

8. On every service there shall be a cut-off, back of all fixtures.

9. Meters with 1-2 inch delivery will be furnished any property holder under the following conditions: The place of setting the meter shall be satisfactory to the Superintendent; the cost of such setting and any damage to the meter by frost, hot water or improper usage, shall be paid for by the property holder.

10. Meters larger than 1-2 inch delivery will be furnished under similar conditions, on property holders paying extra cost of the larger meter.

11. Persons using meters must connect all the fixtures supplied with water on their premises with such meters, so that all water used will be measured, and all water passing through meters must be paid for, whether used or wasted.

12. Water used through two or more meters upon the same premises, for the same business, or to supply the same pipes used for a common supply, shall be rated as passing through one meter; if used through separate pipes for different kinds of business, each meter shall be rated separately.

13. Premises of different individuals shall not be supplied through one meter.

14. If from any cause a meter fails to register the amount of water passing through it, the consumer will be charged at the average daily rate as shown by the meter when in order.

15. The City reserves the right to put in a meter at its own expense, and charge for measured water instead of schedule rates.

16. Meter rates are payable quarterly, and in no case where a meter is used shall the quarterly charge for water be less than \$2.00, provided the annual charge for water shall not exceed \$8.00 except when four thousand cubic feet have been used.

17. The use of hose for any purpose more than two hours a day, the use of nozzles larger than 1-4 inch in diameter, the use of fountains and lawn sprinklers after dark, and the use of fixtures with a constant flow are forbidden, unless the premises where such fixtures are used are supplied through meters.

Attention is called to the penal clauses in sections 7, 8, 9, 10, 11, 13, 14 and 15 of the amended Ordinance entitled Water Department. Approved December 7, 1892.

YEARLY WATER RATES.

For one family, 1 faucet.....	\$6 00
Each additional faucet	1 00
Two families using 1 faucet, each.....	6 00
Three or more families using 1 faucet, each..	5 00
One water closet.....	4 00
Each additional water closet.....	2 00
Urinals, each.....	4 00
One bath-tub.....	4 00
Each additional bath-tub.....	2 00
Groceries and dry goods stores, each.....	6 00
Offices in detached building, 1 faucet, each....	6 00
Offices in a block, 1 faucet, each.....	4 00
Two or more offices using one water closet or urinal each.....	3 00

Churches and schools, 1 faucet, each	\$6 00
Barber shop, 1 chair	6 00
Each additional chair	1 00
Blacksmith shop	5 00
Steam boiler, meter rate	
Steam or hot water heater	2 00
Private horses, each	3 00
Truck horses, each	2 00
Livery and boarding horses, each	3 00
Hose for garden, etc., not to exceed $\frac{1}{2}$ inch nozzle, 2 , hours each day	4 00
Lawn sprinkler	8 00
Cows, each, payable December collection	1 50
Brick laying per M	05
Stone laying per perch	1 $\frac{1}{2}$
Plastering per 100 yards	25

MONTHLY METER RATES.

For the first 4,000 cubic feet	20 c. per 100 cub. ft.		
From 4,000 c. f. to 6,000 c. f., for ea. add. 100 c. f.	15 c.	"	"
" 6,000 c. f. to 10,000 " " "	12 c.	"	"
" 10,000 c. f. to 20,000 " " "	11 c.	"	"
Above 20,000 cubic feet, " " "	10 c.	"	"

ABSTRACT OF AN ORDINANCE RELATING TO A PAID FIRE DEPARTMENT.

Adopted March 21st, and Approved March 22d, 1895.

SEC. 17. The Chief Engineer, subject to the direction of the Committee on Fire Department, shall have the supervision, care and control, in case of fire, of all hydrants * * * and he shall immediately report after the use of any hydrants, to the Superintendent of the Water Department.

1895.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by U. S. census, 1890, 14,590.

Works constructed 1867-8.

Owned by city.

Source of supply, Lake Champlain.

Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel $\left\{ \begin{array}{l} a \text{ Anthracite.} \\ b \text{ Grate.} \\ c \text{ Pittston.} \\ e \text{ \$4.65 and \$4.78.} \end{array} \right\} 44 \text{ weeks.}$
 $g \text{ Mill shavings, \$38.50 per week, 8 weeks.}$
6. Total pumpage for the year, 324,158,575 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
- Cost of pumping figured on pumping station expenses,
 $\$9,014.94.$
11. Per million gallons raised against dynamic head into reservoir, \$27.50.

12. Per million gallons raised one foot high (dynamic),
\$0.087.

Cost of pumping figured on total maintenance, \$45,878.43.

13. Per million gallons raised against dynamic head into
reservoir, \$141.53.

14. Per million gallons raised one foot high (dynamic),
\$0.447.

FINANCIAL.

MAINTENANCE.

Division I.

RECEIPTS.		EXPENDITURES.	
From Consumers :			
A.	Water rates, domestic.....\$34,161 77	AA.	Management and repairs..\$34,503 43
B.	Water rates, manufacturing 5,431 62	BB.	Interest on bonds.....11,375 00
C.	Net receipts for water.....\$39,593 39	CC.	Total maintenance.....\$45,878 43
D.	Miscellaneous.....3,161 57	DD.	Balance to the City Treas- urer.....5,295 53
E.	Total.....\$42,754 96		
From Public Funds :			
F.*	Hydrants.....\$ 6,140 00		
H.	Street watering..1,509 00		
I.*	Public buildings..270 00		
J.*	Water'g troughs 500 00		
	\$ 8,419 00		
K.	Gross receipts from all sources.....\$51,173 96	EE.	Total.....\$51,173 96

*For two years.

Division II.

From fixed rates,	{	L. Domestic....	\$19,787 25
		M. Manufacturing	100 00
		<hr/>	
		N.....	\$19,887 25
From meter rates.	{	O. Domestic....	\$22,795 52
		P. Manufacturing	5,331 62
		<hr/>	
		Q.....	\$28,125 14
		Total.....	<hr/> \$48,012 39

CONSTRUCTION.

RECEIPTS.		DISBURSEMENTS.	
T. Appropriations.....	\$4,856 78	FF. Extension of mains.....	\$3,756 78
		GG. Extension of services.....	1,100 00
V. Total.....	\$4,856 78	KK. Total.....	\$4,856 78
W. Cost of works to date.....			\$454,949 66
X. Bonded debt at date.....			248,000 00
Y. Value of sinking fund at this date.....			144,235 94
Z. Rate of interest, four per cent.			
Toward paying the entire bonded debt of the city..			\$547,000 00

CONSUMPTION.

1. Estimated total population at date, 16,700.
2. " " " on lines of pipe, 16,300.
3. " " " supplied, 16,100.
4. Total number of gallons consumed for year, 324,158,575.
5. Passed through domestic meters, 87,170,932, or 26.89 per cent.
6. Passed through manufacturing meters, 32,469,615 gallons, or 10 per cent.
7. Average daily consumption, 888,083 gallons.
8. Gallons per day to each inhabitant, 53.
9. Gallons per day to each consumer, 55.
10. Gallons per day to each tap, 299.

DISTRIBUTION.

MAIN.	SERVICES.
1. Kind of pipe, cement lined, cast-iron, wrought iron.	16. Galvanized iron, lead.
2. Size, from four to 24 inches.	17. From one-half to six inches.
3. Extended, 7,483 feet.	18. 8,789 feet.
4. Discontinued, 3,515 feet.	19. 56 feet.
5. Total now in use, 35.65 miles.	20. 16 miles, or 84,549 feet.
6. Cost of repairs per mile, \$30.	21. Service taps added, 184.
7. Leaks per mile, 1.4.	22. Number now in use, 2,969.
8. Small distribution pipe less than four-inch, total length, 14,719 feet.	23. Average length of service, 37.9 feet.
9. Hydrants added, 8.	24. Average cost of service, \$9.
10. Number now in use, 195.	25. Meters added, 179.
11. Stop-gates added, 83.	26. Number now in use, 1,261.
12. Number now in use, 486.	a. domestic, - 1,186.
13. Small stop-gates less than four-inch, total 60.	b. manufacturing, 75.
14. Number of blow-off gates, 10.	27. Motors and elevators added, 8.
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.	28. Number now in use, 29.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons,
 Iron tank, high service, capacity 169,617 gallons.

1896.

THIRTIETH ANNUAL REPORT



OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.,

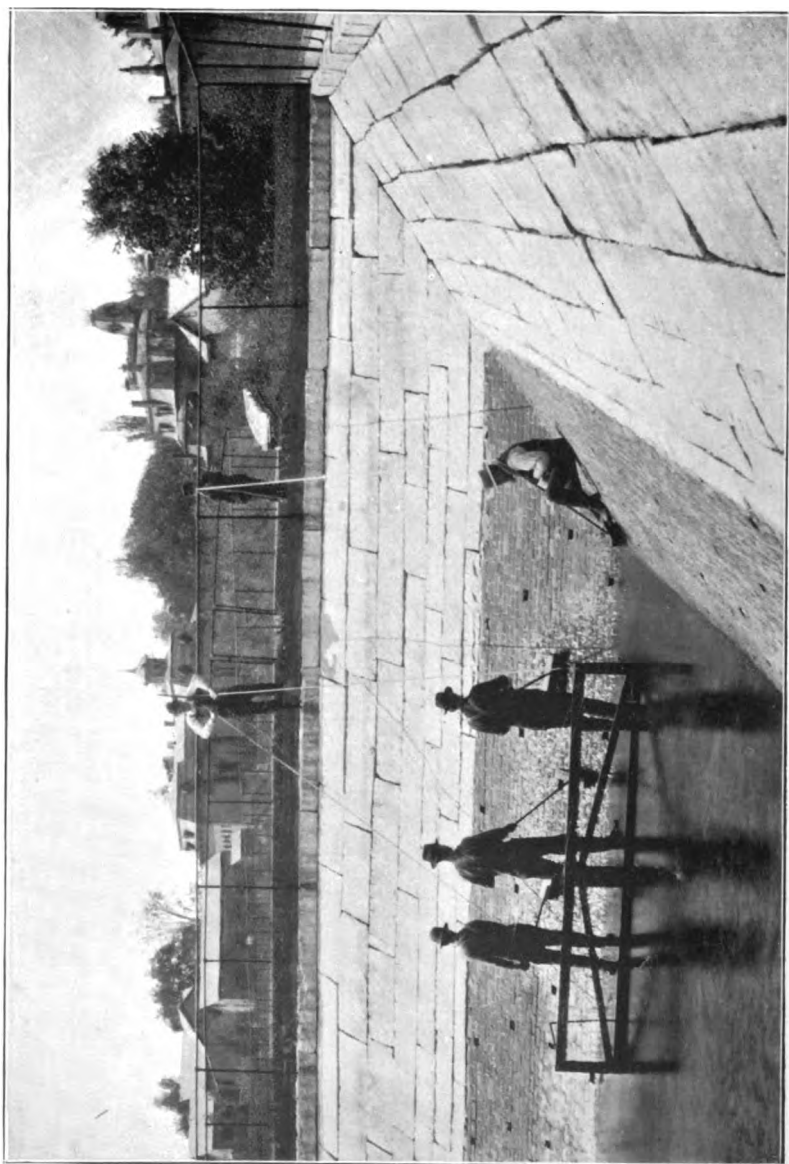
AND OF THE

WATER COMMISSIONERS

THE EIGHTH.

DECEMBER 31, 1896.

BURLINGTON :
FRENCH PRESS ASSOCIATION,
PRINTERS AND BINDERS.
1897.



"CLEANING RESERVOIR."

THIRTIETH ANNUAL REPORT

OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.,

AND OF THE

WATER COMMISSIONERS

THE EIGHTH.

DECEMBER 31, 1896.

BURLINGTON :
FREE PRESS ASSOCIATION,
PRINTERS AND BINDERS.
1897.

EIGHTH ANNUAL REPORT
OF THE
Water Commissioners.

To the Honorable Board of Aldermen, City of Burlington :

GENTLEMEN :—In compliance with the city ordinance the Water Commissioners respectfully submit the following, their report for the year ending December 31st., 1896.

This year, for the first time since 1885, during which period the excess of the receipts of this department over expenditures to the amount of over \$58,000 have been turned into the City Treasury and used for other than water works purposes, appropriations have been made for current expenses in excess of the receipts of the department.

Whether or no the cost of replacing cement pipe is properly chargeable to current expense, as has been the custom, is a matter on which there is room for difference of opinion. There has, during the past decade, been charged up to current expenses of the water department over \$70,000, which might in our opinion with greater propriety have been charged to construction.

The receipts of the department for the year amount to \$47,205.01 (the largest per million gallons pumped, in the history of the department) which, when allowance is made for

the large amount of unpaid bills of 1894, collected in 1895, shows fully the usual increase over the receipts of the year preceding. For details of work and expenditures see the report of the Superintendent hereunto appended.

The wisdom of the unusual expenditure in replacing cement pipe during the past season is, we think, amply demonstrated in the decrease in number of bursts on cement pipe.

It having been deemed by your Honorable Board inexpedient at the present time to appropriate sufficient funds for the purchase of a suitable fire pump for the high service, a Worthington Duplex steam pump $7\frac{1}{2} \times 7 \times 10$ has been procured, which, in connection with a portable boiler used for other purposes, enables the department in case of an emergency to considerably augment the high service supply.

The constant decrease in consumption during the past four years shown by the pumping record at the low service station, accompanied as it is by an increase of receipts per million gallons pumped, each year, is a gratifying result of the increase in number of services, all leaks and losses through which are at the expense of the water taker.

That this decrease should take place in spite of the constant extension of our city sewers, the steady growth in population of the city and more rapid increase in the number of water fixtures and opportunities for the waste of water, is conclusive evidence of the extravagant waste or unremunerative use which has in past years been taking place. This condition of affairs is also an emphatic demonstration of the fact that the best, and in fact the only method of interesting the general public in the restriction of waste, is the making of the subject one of individual pecuniary interest.

We feel that time expended in enabling our tax payers to form a correct idea of the value and reliability of the water meter as a recorder and keeper of accounts, could not be better expended, and we sincerely hope that any tax payer, doubting the record of his meter, will accept the invitation of the Superintendent to see the meter tested and look carefully and thoroughly into the matter.

We had hoped to be able at this time to chronicle the results of "the first steps towards securing our needs at the pumping station," which in our report of two years ago it was stated "had been taken," and in our report of last year "were still in progress," and much regret that it again becomes our duty to impress upon your Honorable Board the urgent necessity of securing without unnecessary delay, a title to the premises we now occupy as a pumping station.

When the purchase of the pumping station premises is accomplished, there would seem to be no longer any good reason for delaying negotiation for the purchase of machinery more adequate to our needs, and capable of operation with greater economy, than it was possible to realize at the time of the installation of our present plant.

Before the installation of new pumping machinery, provision should be made for the economical conveyance of its discharge to the reservoirs; facilities should also be afforded for obtaining, throughout the distribution system, the advantages to be derived from the increased pumping capacity.

The annual receipts of the water department are at present, and will be in the future, if the policy of selling water is continued, sufficient to pay the interest on the bonded debt and other indebtedness of the city incurred for that depart-

ment, when increased by a sum sufficient to purchase the pumping station premises, properly improve and place a suitable building and pumping engine on the same, and put down the piping immediately necessary, beside paying all other current expenses of the department, turning over to the treasurer for a sinking fund, the sum required by the City Charter, and making some very desirable changes and reduction of rates, relative to which we hope to communicate with your Honorable Board at an early date.

All of which is respectfully submitted

J. E. LANOU,	}	Water Commissioners.
A. ADSIT,		
JOHN J. FLYNN,		

THIRTIETH ANNUAL REPORT
OF THE
Superintendent of Water Works.

*To the Honorable the Board of Water Commissioners of the
City of Burlington, Vt:*

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31st, 1896.

ACCOUNT WITH THE CITY TREASURER.

FUNDS AVAILABLE FOR THE USE OF THE WATER DEPARTMENT.

Balance from 1895.....	\$	1	36
Sale of pipe, meters, etc.....		2,137	79
Appropriations		42,300	00
Less balance from 1895 returned to City Treasury.....			1 36
			<hr/> \$44,437 79
Receipts from City Treasurer.....			44,436 59
			<hr/>
Unexpended balance.....			\$1 20

DISBURSEMENTS.

Construction :

Cast iron pipe, packing and lead.....	\$	245	00
Labor on mains.....		915	33
Labor on services.....		575	65
Gates and boxes.....		144	84
Material for services.....		221	94
Hydrants		325	67
			<hr/> \$2,428 43

Current :

Pay rolls, current work.....	\$3,936 02
Pay rolls, work for individuals.....	773 01
Other departments.....	1,328 65
Material for individuals.....	1,140 31
Plumbers' bills.....	1,121 47
Superintendent's salary.....	1,000 00
Keeping three horses, shoeing, repairs, etc.....	682 97
Freight and cartage.....	480 00
Office assistant....	400 00
Material for management and repairs....	380 23
Investigation relative to sequestration of pump station.....	354 52
Gate and cut-off boxes.....	343 05
Repair of hydrants.....	333 70
Water Commissioners' salary.....	300 01
Hydrants	245 00
Bills for labor.....	272 34
Repair of tools.....	263 85
Office expenses.....	189 46
Repair and cleaning High Service Tank.....	184 88
Printing, advertising and postage.....	164 10
Reservoir repairs and care of grounds....	152 52
Hardware.....	119 63
Sanitary examination of water and test- ing of conduit.....	115 00
Typewriter.....	100 00
Telephone rent.....	84 00
Damages on account of cement pipe bursts	28 37

Replacing cement with cast iron pipe :

Pipe	\$6,096 41	
Labor	5,249 46	
Gates	759 64	
Packing and lead	322 71	
	<u> </u>	\$12,428 22
		<u> </u> \$26,921 81

Pumping :

Fuel	\$ 6,739 32	
Pay rolls	2,267 88	
Repairs to machinery	266 82	
Supplies	154 64	
Repairs to motor	244 68	
Repairs to building and grounds	81 91	
Fuel and light at Motor House	41 31	
Incidentals	7 05	
Piping at Motor House	143 70	
Portable boiler and pump	446 22	
Scales and hoist	102 50	
Filling High Tank	82 35	
	<u> </u>	\$10,578 38

Meters :

Meters	\$ 3,496 91	
Pay rolls	920 00	
Repairs and freight	91 06	
	<u> </u>	\$4,507 97

RECAPITULATION.

RECEIPTS.

Received of City Treasurer	\$44,436 59
----------------------------------	-------------

EXPENDITURES.

Construction.....	\$ 2,428 43
Current	26,921 81
Pumping	10,578 38
Meters.....	4,507 97
	<u>\$44,436 59</u>

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates.....	\$15,734 60
Meter rates.....	31,470 41
	<u>\$47,205 01</u>

DISBURSEMENTS.

Paid L. C. Grant, City Treasurer.....	\$47,205 01
---------------------------------------	-------------

We, the undersigned, have examined the books and vouchers for the year 1896 of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

GEO. W. BECKWITH,
JOHN C. FARRAR,
F. W. WRIGHT. } Auditors.

Statement of assessments and expenditures for year ending December 31st, 1896.

ASSESSMENTS.		EXPENDITURES.	
PAID.		Int. on \$248,000	
Meter rates...\$30,064 50		Bonds @ 4%	\$9,920 00
Schedule rates 15,268 29		Int. on \$12,000	
	<u>\$45,332 79</u>	Notes.....	480 00
Material and		Int. on \$5,000	
labor	1,896 08	Notes @ 5%	250 00
			<u>\$10,650 00</u>
UNPAID.		Management	
Meter rates...\$ 58 10		and repairs.	12,579 77
Schedule rates 126 91		Labor and	
	<u>\$ 185 01</u>	Material for	
Material and		individuals.	1,913 82
labor	20 49	Replacing ce-	
		ment pipe..	12,428 22
	<u>\$47,434 37</u>	Pumping.....	10,578 38
Appropriation		Meter	4,507 97
from tax			<u>\$42,008 16</u>
levy.....	\$5,223 79	Total main-	
	<u>\$52,658 16</u>	tenance....	52,658 16
			<u>\$52,658 16</u>

WATER PUMPED.

	1893. Gallons.	1894. Gallons.	1895. Gallons.	1896. Gallons.
January	30,881,900	29,958,675	25,888,800	22,696,950
February	26,833,000	21,958,825	35,281,175	20,948,800
March	27,705,625	23,776,750	24,778,725	22,082,975
April	27,479,700	25,981,800	21,988,100	23,377,700
May	26,288,550	27,271,475	28,209,475	32,987,775
June	35,525,900	33,628,700	33,827,350	27,324,975
July	32,414,225	32,900,600	32,414,925	32,185,600
August	24,274,475	32,496,775	27,411,450	29,720,050
September	30,066,300	32,499,925	26,287,975	25,046,300
October	26,526,675	28,856,050	26,795,525	25,174,450
November	20,761,400	24,088,050	20,693,400	22,891,200
December	29,335,600	29,697,600	21,731,675	21,435,250
Total	337,493,350	336,504,725	324,158,575	305,817,025
Decrease		988,625	12,346,150	18,341,550 ✓
Daily average..	924,639	921,930	888,105	835,565 ✓

SERVICES.

There have been added 105 services of the following sizes :

Eighty-nine	$\frac{1}{2}$	inch
Eight	1	"
Three	$\frac{3}{4}$	"
Two	2	"
Two	$1\frac{1}{2}$	"
One	4	"

The following services have been discontinued :

Ladies of Nazareth, North Prospect Street...	1	one half inch
Coffee, South Union Street	1	" " "
Lyman, South Willard Street	1	" " "
Street Railway Company, North Winooski Ave-	"	" " "
nue	2	" " "
Burlington Cotton Mills Company, Pine Street	1	" " "
Dolan, Howard Street	1	" " "
Burlington Cotton Mills Company, St. Paul		
Street	1	one inch
Total discontinued	—	

HYDRANTS.

Post hydrants have been placed in the following new locations :

Elmwood Avenue, Northwest corner Pearl Street.

Pine, Northwest corner Main.

Cedar, Northeast corner Rose.

Buell, Northeast corner Union.

Kilburn Street, north side.

King Street, east of railroad tracks.

The following flush hydrants have been replaced with post hydrants :

St. Paul Street between Marble Avenue and Howard Street.

St. Paul Street at Howard.

Pomeroy Street at Prospect.

Hydrants at the following street intersections have been relocated as follows :

Battery, at Main Street, Southeast corner.

Champlain and Main, Northeast corner.

Main and St. Paul, Northeast corner.

Church and Main, Southwest corner.

Howard and South Union, Northeast corner.

Main and Prospect, Northwest corner.

The 4 inch cement fire services of the Burlington Cotton Mills Company on both Pine and St. Paul streets have been replaced with 6 inch cast iron pipe. One private post hydrant has been added to the service on the premises of the said Company.

Total number of public hydrants.....	174
Total number of private hydrants.....	28
Total.....	202

SUPPLY PIPE.

One hundred and fifty feet of supply pipe on Pomeroy Street extending westerly from Prospect, has been discontinued, and the supply pipe in Hayward Street extending westerly from Marble Avenue, has been increased fifty feet in length.

Total length now in use..... 14,619

MAINS.

New mains have been laid in the following streets:

WITH 6 INCH CAST-IRON PIPE.

Buell Street from dead end to Union Street.....	130
Union Street between Pearl and College.....	401
Loomis Street from Willard Street, westerly to dead end..	310
Kilburn Street, westerly from Pine.....	200
Booth Street, northerly from Loomis.....	216
King Street, westerly from Battery.....	200

WITH 4 INCH CAST-IRON PIPE.

Summit Street, northerly from dead end.....	156
Marble Avenue, westerly from dead end.....	178
Pomeroy Street, westerly from Prospect.....	150

Total length of new mains..... 1941

The cement pipe in the following streets has been replaced:

WITH 16 INCH CAST-IRON PIPE.

Main Street from Battery to Church.....	1584
---	------

WITH 10 INCH CAST-IRON PIPE.

Howard from Union to St. Paul Street.....	556
South Union Street from Howard St. main, South.....	56

WITH 8 INCH CAST-IRON PIPE.

St. Paul Street northerly from Main Street.....	36
---	----

WITH 6 INCH CAST-IRON PIPE.

Champlain Street at Main Street.....	140
St. Paul Street at Main Street.....	100
Church Street at Main Street.....	100
Hyde Street from north line of Pomeroy southerly.....	73
Pomeroy from Hyde Street easterly.....	30
Cedar Street from Elmwood Avenue at Rose Street.....	610
Lafountain Street northerly from North Street.....	455
St. Paul Street from end of iron pipe to Union.....	1819
Elmwood Avenue from Pearl to North Street.....	1267
South Union Street from Howard St. main, northerly....	17
Allen Street from Elmwood Avenue westerly.....	23
Interval Avenue from North to Spring Street.....	648

Total length of cement pipe replaced..... 7514

The 8 inch C. I. pipe in Pine Street, from the south line of Main Street northerly, has been lowered and connected with the new 16 inch main in Main Street..	220
The 4 inch C. I. pipe in Union Street, northerly from College Street, has been taken up and replaced with 6 inch cast-iron pipe.....	317

Total lengths of mains replaced..... 8051

LENGTH OF PIPE NOW IN USE.

Cement.....	57,989 feet.	11 miles —
Iron.....	132,187 “	25 “ +
	<hr/>	<hr/>
Total.....	190,176 “	36 +

GATES.

The following gates have been discontinued :

Main Street at east line of Church.....	1	10	inch.
Champlain Street south line of Main.....	1	4	"
Lafayette Place at Pearl street.....	1	4	"
St. Paul Street at Main street.....	2	4	"
Howard Street at St. Paul street.....	1	4	"
Howard Street at Union street.....	2	4	"
St. Paul Street at end of iron pipe.....	1	4	"
St. Paul Street at Howard street.....	2	4	"
Hyde Street at Pomeroy street.....	1	3	"
Cedar Street at Elmwood avenue.....	1	4	"

Total number of gates discontinued...13

The following gates have been set during the past season :

Main Street at Battery.....	2	16	inch.
Main Street at Pine.....	2	16	"
Main Street at Church.....	2	16	"
Howard Street at St. Paul.....	2	10	"
Howard Street at Union.....	2	10	"
Union Street at Howard.....	1	10	"
Pine Street at Main.....	2	8	"
St. Paul Street at Main.....	1	8	"
Champlain Street at Main.....	2	6	"
Buell Street at Union.....	1	6	"
Union Street at Buell.....	2	6	"
Loomis Street at Willard.....	1	6	"
Kilburn Street at Pine.....	1	6	"
Booth Street at Loomis.....	1	6	"
On hydrant branch, St. Paul and Main streets..	1	6	"
King Street at Battery.....	1	6	"
Hyde Street at Pomeroy.....	1	6	"

Pomeroy street at Hyde street.....	1	6 inch.
Cedar street at Lafountain.....	2	6 "
Lafountain street at Cedar.....	2	6 "
Cedar street at Elmwood avenue.....	1	6 "
St. Paul street opposite No. 409.....	1	6 "
St. Paul street at Howard.....	2	6 "
Interval avenue at Elmwood avenue.....	1	6 "
Elmwood avenue north of Interval avenue.....	1	6 "
Prospect street at North.....	1	4 "
Loomis street at Prospect.....	1	4 "
Pomeroy street (north branch) at Prospect.....	1	4 "
Lafayette Place at Pearl street.....	1	4 "
<hr/>		
Total added.....	40	
Total now in use.....	513	

REPAIRS.

The repairs for the year have been :

On cement pipe.....	4 breaks.
On cement pipe.....	7 leaks.
On cement pipe.....	1 pick hole.
On iron pipe.....	2 plug.
On iron pipe.....	1 sand hole.
On iron pipe.....	12 joints.
On service pipes.....	9 leaks.
On broken hydrants.....	27
On broken gates.....	2

METERS.

There are now in use 1,552 meters, an increase of 291 over last year.

Of the water pumped, about 41 per cent. has been used through meters, yielding about 66 per cent. of the assessments.

The receipts of the water department for 1896 demonstrate conclusively, as they have for years, that the metered services are yielding more than their share of the revenue of the department.

The steady increase in favor of the use of water meters has rendered it necessary for the water department to provide itself with suitable facilities for the examination and care of these "Brass Clerks" of the department.

For several years past every meter received by the department has been found by test to register accurately before acceptance, and parties doubting the accuracy of meters have been afforded an opportunity of witnessing an examination of the meter in question, with the assurance that, in case the machine was not conclusively proved to be accurate in registration, the error should be rectified.

The effect of a more general information relative to the working of water meters, resulting from the witnessing of meter tests, the examination of meters and the acquiring of a knowledge of the practice of the department relative to them, by interested taxpayers, is apparent in the less frequent arraignment of these automatic machines for prevarication, and the general abandonment of the idea that there is anything hidden, erratic or incomprehensible about a water meter.

The pumping machinery, both at the low and high service stations, is in good repair, and if the conditions relative to waste of water which have obtained during the past four years continue, will be as adequate for our needs for some years to come, as they have been during those just passed.

Changes and repairs made upon the high service motor during the past season will enable us to handle approximately the same or even a somewhat larger quantity of water than

the maximum of recent years, at a cost not in excess of the average (\$397.80) for the years when the demands upon the motor were not in excess of its rated capacity.

Any considerable increase in the amount of water required to be handled, will necessitate the procuring of pumping machinery of greater capacity.

The quality of our city water continues to be a subject of favorable comment. The opinions of casual observers and of local physicians relative to the same, being fully corroborated by the results of biological examinations, a report of which by Prof. S. O. Prescott, of the Massachusetts Institute of Technology, is presented herewith.

Not the least of the causes of the excellent quality of our water supply is to be found in our improved facilities for storage, and in the maintaining of a constant circulation through the reservoirs and distribution mains. It needs no argument to prove that clean reservoirs are an advantage over such as it is impossible to clean. The intake conduct has been tested again this season in the same manner and with the same satisfactory result as attended the test of last year.

While investigation relative to pumping machinery made prior to the decision to purchase a lot on which to locate it, is somewhat premature, sufficient has been done in this line to develop the fact that machinery capable of putting into our reservoirs 3,000,000 gallons daily can be to-day procured, which will handle our present pumpage for about one-half the present expenditure for fuel. From which it conclusively appears that the city cannot afford to unnecessarily prolong the use of her present pumping machinery.

Respectfully submitted,

F. H. CRANDALL, Supt.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, }
BOSTON, Mass., Nov. 10th, 1896. }

To the Superintendent of Water Works, Burlington, Vt.:

DEAR SIR:—Having been requested by you to make a bacteriological examination of the Burlington water supply for the purpose of determining its present sanitary condition, I have done as you desired, and now have the honor to submit the following report :

In August and September of the present year I carried on an extended series of bacteriological examinations, testing not only the water as it is drawn from both high and low service reservoirs, by means of taps in various parts of the city, but also samples of water from the reservoirs themselves, from the lake at the present intake and at the old intake, from the pump-well at the pumping-station, and from the tap on the pump at the pumping station. I also examined samples of water from the broad lake, water from points at various distances from the sewer outfall, and specimens of sewage, taken at the outfall and from a trunk-sewer. In all some one hundred and four (104) analyses were made.

Through the kindness of Professors Jones and Hills of the University of Vermont, I was enabled to conduct my investigations in the laboratory of the Experiment Station of the University. I gratefully acknowledge my indebtedness to these officials.

In the case of water supplies drawn like that of Burlington from a lake which receives from various points discharges of sewage, there is always a possibility, more or less remote, that unpurified sewage may find its way to the consumers, either directly through the intake or indirectly by leakage into the conduit. It is possible, as a rule, however, to detect the pres-

ence of unpurified sewage by bacteriological examinations and it was for this purpose that my examinations were made.

As a result I have found that the water supply appears to be at present in excellent sanitary condition, and that there is no evidence whatever that it suffers in any degree from sewage contamination. Cultures from the intake showed that the water there was practically pure lake water. The average number of bacteria found at the intake was eighty-two (82) per cubic centimeter, but the number varied somewhat with local conditions such as depth, winds, etc. Cultures from the pump-well showed a somewhat higher bacterial content than those from the intake, but a study of the local conditions of disturbance, etc., and especially an investigation of the character of the cultures, established the fact that this was probably not due to leakage.

It was especially interesting to compare the number of bacteria in the pump-well with the number just outside the pump-well on the lake front, since this is the water, which would have been supplied to the citizens if the intake, had not been extended to Apple Tree Reef. Both in respect to numbers and kinds of bacteria this water was highly objectionable, and showed unmistakable evidence of sewage pollution. In fact my experiments showed that while the bacteria gradually diminish in numbers in passing from the outfall of the sewers to the old intake, the water all along the lake front has a much higher bacterial content than has the water of the broad lake, and the character of the cultures strongly suggests sewage.

The gradual diminution in numbers may be shown by a series of tests.

<i>Source.</i>	<i>Bacteria per c. c.</i>
Sewer.....	1,244,000
Lake, 10 yards north of sewer outfall.....	41,500
Lake, 50 " " " "	6,350
Champlain Co.'s dock.....	3,545
Old intake.....	1,040

The citizens of Burlington are to be congratulated that their water supply is no longer derived from a source so objectionable.

An interesting difference was observed between the water of the high and low service as drawn from the taps, that from the high service being somewhat richer in bacteria. This again is probably to be accounted for by the different conditions as to reservoir and stand pipe in the two cases.

I find no reason whatever, either in the bacterial condition of the water or in the mortality returns, to regard the sanitary conditions as other than excellent at the present time, but as was suggested by Professor Sedgwick in his paper on the Sanitary Condition Past and Present of the Burlington Water Supply in 1895, and bearing in mind the experiences of Toronto, Buffalo and other cities which have suffered from epidemics of typhoid fever caused by the leakage of sewage through broken intake pipes, it will obviously be necessary to repeat these examinations from time to time as a check upon the sanitary condition of the Water Supply.

Respectfully submitted,

SAMUEL C. PRESCOTT.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.
Burlington, Chittenden County, Vermont.
Population by U. S. census, 1890, 14,590.
Works constructed 1867-8.
Owned by city.
Source of supply, Lake Champlain.
Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel

{	<i>a</i> Anthracite. <i>c</i> Grate. <i>d</i> Pittston. <i>e</i> \$4.65, \$5.10 and \$5.35.
---	--
6. Total pumpage for the year, 305,817,025 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
Cost of pumping figured on pumping station expenses, \$10,578.38.
11. Per million gallons raised against dynamic head into reservoir, \$34.59.

12. Per million gallons raised one foot high (dynamic) \$0.109.
Cost of pumping figured on total maintenance,
\$52,658.16.
13. Per million gallons raised against dynamic head into
reservoir, \$172.19.
14. Per million gallons raised one foot high (dynamic), \$0.535.

FINANCIAL.

MAINTENANCE.

Division I.

RECEIPTS.		EXPENDITURES.	
From Consumers:		AA. Management and repairs..	\$42,008 16
A. Water rates, domestic.....	\$36,513 32	BB. Interest on bonds.....	10,650 00
B. Water rates, manufacturing.....	4,621 78	CC. Total maintenance.....	52,658 16
C. Net receipts for water.....	\$41,135 10		
D. Miscellaneous.....	1,896 08		
E. Total.....	\$43,031 18		
From Public Funds:			
F. Hydrants.....	\$ 3,360 00		
H. Street watering....	1,889 91		
I. Public buildings			
and parks.....	570 00		
Watering troughs	250 00		
	\$6,069 91		
J. General appropriation.....	\$ 3 557 07		
K. Gross receipts from all		EE. Total.....	\$52,658 16
sources.....	\$52,658 16		

Division II.

From fixed rates,	{	L. Domestic....	\$15,734 60
		M. Manufacturing	<u> </u>
		N.....	\$15,734 60
From meter rates,	{	O. Domestic	\$26,848 63
		P. Manufacturing	<u>4,621 78</u>
		Q.....	\$31,470 41
		Total.....	<u>\$47,205 01</u>

CONSTRUCTION.

RECEIPTS.		DISBURSEMENTS.	
T. Appropriations	\$2,428 43	FF. Extension of mains	\$1,630 84
		GG. Extension of services	797 59
V. Total	\$2,428 43	KK. Total	\$2,428 43

W. Cost of work to date.....\$457,378 09

X. Bonded debt at date..... 265,000 00

Y.* Value of sinking fund at this date. 152,458 46

Z. Rate of interest, four per cent.

*Toward paying the entire bonded debt of the
city..... 592,000 00

CONSUMPTION.

1. Estimated total population at date, 17,300.
2. " " " on lines of pipe, 16,900,
3. " " " supplied, 16,700.
4. Total number of gallons consumed for year, 305,817,025.
5. Passed through domestic meters, 107,786,961 gallons,
or 35.2 per cent.
6. Passed through manufacturing meters, 18,291,510 gal-
lons, or 6 per cent.
7. Average daily consumption, 835,565 gallons.
8. Gallons per day to each inhabitant, 48.
9. Gallons per day to each consumer, 50.
10. Gallons per day to each tap, 272.

DISTRIBUTION.

MAIN.

1. Kind of pipe, cement lined, cast iron, wrought iron.
2. Size from 4 to 24 inches.
3. Extended, 9992 feet.
4. Discontinued, 8051 feet.
5. Total now in use, 36 miles.
6. Cost of repairs per mile, \$9.00.
7. Leaks per mile, 0.75.
8. Small distribution pipe less than four-inch, total length, 14,619 feet.
9. Hydrants added, 7.
10. Number now in use, 202.
11. Stop-gates added, 27.
12. Number now in use, 518.
13. Small stop-gates less than four-inch, total 60.
14. Number of blow-off gates, 10.
15. Range of pressure on mains at center, for day and night 70 to 85 pounds.

SERVICES.

- 16.d eGalvaniziron, lead.
17. From one-half to six inches.
18. 3,241 feet.
19. 211 feet.
20. 16.5 miles or 87,579 feet.
21. Service taps added, 98.
22. Number now in use, 3067.
23. Average length of services, 32, 34 feet.
24. Average cost of service, \$9.17.
25. Meters added, 291.
26. Number now in use, 1,552.
 - a. domestic..... 1,501.
 - b. manufacturing... 51.
27. Motors and elevators added, 1.
28. Number now in use, 30,

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons ; iron tank, high service, capacity 169,617 gallons.

THIRTY-FIRST ANNUAL REPORT
of the
WATER DEPARTMENT
of the
CITY OF BURLINGTON, VT.,
and of the
WATER COMMISSIONERS
THE NINTH.

December 31, 1897.

BURLINGTON :
FREE PRESS ASSOCIATION,
PRINTERS, BINDERS AND STATIONERS.
1898.

.....1 . \$.....

REFERENCE LIBRARY.

Metropolitan Water Board.

ENGINEERING DEPARTMENT.

Room..... *Bookcase*.....

Division..... *Shelf*.....

No......

This book belongs to the Engineering Department of the Metropolitan Water Board, Boston, Mass.

Persons using this book must take due care thereof and return it without delay to the bookcase after using.

None of the books to be taken from the Engineering Department without the permission of the Chief Engineer, and receipt given therefor.

All persons will be required to observe the above regulations.

By order of the Chief Engineer.

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PRINTERS, BINDERS AND STATIONERS.
1898.

Board of Water Commissioners.

J. E. LANOU, *Chairman*, (Term expires 1900.)

ALVARO ADSIT, (Term expires 1898.)

JOHN J. FLYNN, (Term expires 1899.)

OFFICERS.

FRANK H. CRANDALI, C. E., *Superintendent*.

JOEL W. THOMAS, *Engineer at Pumping Station*.

WILLIAM CASSIDY, *Foreman*.

OSCAR HEININGER, *Chief Inspector*.

Miss F. P. EADY, *Bookkeeper*.

Miss KITTIE M. McCAFFREY, *Office Assistant*.

NINTH ANNUAL REPORT
OF THE
Water Commissioners.

To the Honorable the City Council, City of Burlington:

GENTLEMEN:—In compliance with the city ordinance the Water Commissioners respectfully submit the following, their report for the year ending December 31st, 1897.

The receipts from water rates for the year, \$45,183.32, though on account of the unusually wet season about \$2,000 less than for 1896, are considerably more than sufficient to cover all necessary expenses of maintenance.

The amount of the unpaid bills carried forward, \$79.53, is \$105.48 less than in 1896. There has been this year deposited in the City Treasury, in compliance with a requirement of the revised city charter, the sum of \$2,360.25, that being "A sum not less than five per cent of the amount of the gross receipts from all sources derived from the use of water for the year ending the 31st of December of the year previous." Which sum the charter provides "shall be placed to the credit of the sinking fund to be applied in the reduction of the bonded and other indebtedness of the city incurred for the benefit of the water department."

That a larger amount was not carried to the sinking fund this year is due to the undertaking of work herein mentioned, not strictly speaking essential to maintenance, and not to a failure of collections to furnish a surplus.

Since the interest on the water debt has been required to be paid from the funds provided for the current expenses of the water works, the accounts of the department furnish a full and complete record of current expenses.

In the current expenses account for the year are included large items for new mains in streets in which it was desired to improve the roadway, for increasing the capacity of discharge from the reservoir and for the installation of auxiliary machinery at the high service station. These items, though perhaps under the circumstances, properly charged to this account, are not, strictly speaking, necessary expenses of maintenance.

Were such items as those just mentioned not included in this account, the receipts from water rates would be found sufficient to more than cover the current expense account, and a reduction of rates or a larger deposit to the sinking fund might be made.

By a glance at the pumping record it may be seen that another year has been added to the uninterrupted succession of years since 1893, during which a constantly increasing decrease of the pumping record has taken place.

The falling off of twenty-three million gallons this year makes the total decrease since 1893 about fifty-five million gallons and shows the average daily demand made upon the pumping machinery to have been about two hundred thousand gallons less than in 1893.

The pumping machinery at the lake is in excellent condition and is as capable of supplying our needs to day as it was five years ago. This fact, however, we would have borne in mind, furnishes no good reason why we should not at an early date procure modern machinery of greater capacity.

The additional space secured at the low service station renders machinery stored in fire proof buildings, so-called, safe from any conflagration which can occur in that locality.

We would recommend that the stone boundary posts, mentioned in the deed to the city of this property, be set and properly marked by the City Engineer and a representative of the railroad company.

We understand that the railroad company have signified their readiness to participate in this marking whenever requested to do so.

The area included in the high service, which has increased far beyond the limits originally intended, can, since the recent increase in size of the low service mains in that section, and the consequent ability to furnish satisfactory pressure from the low service, be considerably diminished. With all unnecessary demands cut off, it will be possible with the present machinery to supply the needs of the high service for a number of years to come.

Since the decision of the Committee on Public Buildings and Parks to meter the park fountains, there has been less than one-fourth the usual amount of water turned in to the sewers through those fixtures, and this saving has been effected without curtailment of the usefulness or beauty of the fountains.

With the result in the case of the park fountains in mind, remembering the constantly increasing number of meters in

use and the unusually wet season, it is not a difficult matter to discern the reason for the steady decrease in our consumption which has taken place during the past four years as well as the reason for the unusual decrease of the past year.

For details of the season's work and expenditures, reference is made to the report of the Superintendent hereunto appended.

Respectfully submitted,

J. E. LANOU,
A. ADSIT,
JOHN J. FLYNN, } Water
Commissioners.

THIRTY-FIRST ANNUAL REPORT
OF THE
Superintendent of Water Works.

*To the Honorable Board of Water Commissioners of the
City of Burlington, Vt.:*

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31st, 1897.

RECEIPTS.

App. by charter for current expenses.....	\$44,844 76
“ “ “ “ sinking fund.....	2,380 25
From sales of material, permits, etc.....	2,115 86
Other appropriations for current expenses..	2,900 00
	<hr/>
Total for cur. exp. and sinking fund..	52,220 87
Appropriation for construction.....	2,250 00
	<hr/>
	\$54,470 87

DISBURSEMENTS.

Construction :

Cast iron pipe.....	\$ 859 43
Labor on mains.....	872 12
Labor on services.....	354 45
Packing and lead.....	44 00
Material for services.....	120 00
	<hr/>
	\$ 2,250 00

Current :

Interest on bonds.....	\$10,650 00
Pay rolls.....	7,573 97
Superintendent.....	1,133 32
Plumbers' bills.....	890 95
City of Burlington, other departments....	634 53
Horse keeping, shoeing, repairs, etc.....	623 57
Material for management and repairs.....	543 28
Installation of steam plant at high service station.....	473 54
Freight and cartage.....	431 94
Repair of building and furnishing high service station.....	418 65
Book-keeper.....	400 00
Tools.....	384 16
Material for reservoir bank excavation....	368 13
Supplying pipe for Henry Holt.....	365 70
Corporation stops.....	354 63
Horse, wagon and harness.....	327 50
Water Commissioners' salary.....	300 00
Castings.....	271 52
Hydrants.....	250 00
Hydrant repairs....	219 35
Printing, advertising and postage.....	203 74
Private line and care of same.....	200 18
Office expenses.....	172 55
Repair of tools.....	166 08
Telephone rent.....	82 50
Coal at City Hall.....	76 69
Hardware.....	74 50
Biological examination of water.....	62 10
Gas at City Hall.....	50 80

WATER DEPARTMENT.

9

Damages.....	\$24 20	
Cast iron pipe and specials.....	\$3,515 55	
Packing and lead.....	746 22	
Gates.....	857 84	
Pay-rolls.....	4,637 82	
	<u>9,757 43</u>	
		<u>\$37,485 51</u>

Pumping:

Fuel.....	\$4,652 37	
Pay-rolls.....	2,170 47	
Repairs to machinery.....	544 76	
Supplies.....	246 65	
Repairs to motor.....	254 40	
Repairs to building and grounds.....	151 78	
Insurance.....	100 00	
	<u>\$8,120 43</u>	

Meters:

Meters.....	\$3,047 32	
Pay-rolls.....	1,055 15	
Repairs and freight.....	152 21	
	<u>\$4,254 68</u>	

Sinking Fund:

L. C. Grant, City Treasurer.....	\$2,360 25	
	<u>\$2,360 25</u>	

RECAPITULATION.

RECEIPTS.

Received of City Treasurer.....	\$54,470 87
---------------------------------	-------------

EXPENDITURES.

Construction.....	\$ 2,250 00
Current.....	37,485 51

Pumping.....	\$8,120 43
Meters.....	4,254 68
Sinking fund.....	2,360 25
	<u>\$54,470 87</u>

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates.....	\$13,494 32
Meter Rates.....	31,689 00
	<u>\$45,183 32</u>

DISBURSEMENTS.

Paid L. C. Grant, City Treasurer.....	\$45,183 32
---------------------------------------	-------------

We, the undersigned, have examined the books and vouchers for the year 1897 of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

JOHN C FARRAR, }
FRANK W. WRIGHT, } Auditors.

Statement of assessments and current expenditures for year ending December 31st, 1897.

ASSESSMENTS.		EXPENDITURES.	
PAID.		Interest on bonds	\$10,650 00
Meter rates....	\$31,630 90	Repl. cement pipe.....	9,757 43
Schedule rates	13,367 41	Management and re-	
	<u>\$44,998 31</u>	pairs	\$17,078 08
Material and		Pumping.....	8,120 43
labor	2,105 49	Meters.....	4,254 68
	<u>\$47,103 80</u>		<u>29,453 19</u>
UNPAID.			
Meter rates....	\$ 27 35		
Schedule rates	38 10		
	<u>\$ 65 45</u>		
Material and			
labor	55 77		
	<u>\$ 121 22</u>		
	<u>\$47,225 02</u>		
Appropriation			
from tax			
levy	2,635 60		
	<u>\$49,860 62</u>		<u>\$49,860 62</u>

WATER PUMPED.

1893. Gallons.	1894. Gallons.	1895. Gallons.	1896. Gallons.	1897. Gallons.
Jan... 30,331,900	28,958,675	25,338,800	22,696,950	22,416,975
Feb... 26,833,000	21,958,825	35,231,175	20,943,800	19,392,500
March 27,705,625	23,776,750	24,778,725	22,082,975	22,289,075
April 27,479,700	25,981,300	21,988,100	23,377,700	19,707,650
May 26,238,550	27,271,475	28,209,475	32,937,775	21,452,475
June 35,525,900	33,628,700	33,327,350	27,324,975	26,668,375
July 32,414,225	32,300,600	32,414,925	32,185,400	31,461,000
Aug 24,274,475	32,496,775	27,411,450	29,720,050	24,132,200
Sept 30,066,300	32,499,925	26,387,975	25,046,300	24,407,500
Oct 26,526,675	28,856,050	26,795,525	25,174,450	24,144,375
Nov 20,761,400	24,083,050	20,693,400	22,891,200	25,842,550
Dec 29,335,600	29,697,600	21,731,675	21,435,250	20,635,850
Total 337,493,350	336,504,725	324,158,575	305,817,025	282,550,525
Decrease	988,625	12,346,150	18,341,550	23,266,500
Daily average 924,639	921,930	888,105	835,565	774,111

SERVICES.

There have been added 73 services of the following sizes :

Sixty-two.....	$\frac{1}{2}$ inch
Four.....	1 “
Two.....	$\frac{3}{4}$ “
Two.....	2 “
Two.....	$1\frac{1}{2}$ “
One.....	4 “

Three half inch services have been discontinued ; two at the Masonic Temple and one at the Barrows & Bundy Block on Cherry Street.

HYDRANTS.

Post hydrants have been placed in the following new locations :

Johnson Street at Monroe, Northeast corner.

Bank Street at Winooski Avenue, Northwest corner.

Maple Street at the lake.

North Avenue at Front Street.

Marble Avenue at Hayward Street.

Flush hydrants have been replaced with post hydrants as follows :

Prospect at North Street, old location.

Willard at Howard Street, old location.

Bright at First Street, old location.

Main at Williams Street, old location.

Elmwood Avenue at Spring Street, old location.

Prospect at Pearl Street, Northeast corner.

Williams at College Street, Northeast corner.

Hydrants at the following street intersections have been relocated as follows :

North Winooski Avenue at car barn, as before.

Winooski Avenue at Pearl Street, as before.

Buell at Willard Street, as before.

Willard at College Street, as before.

Cherry at St. Paul Street, Northwest corner.

Cherry at Pine Street, Northeast corner.

Pearl at head of St. Paul Street.

Bank at St. Paul Street, Northwest corner.

Winooski Avenue at No. 50 removed to Northwest corner of Winooski Avenue and Cherry.

Six-inch branches have been placed for hydrants on Champlain Street, Main at Northeast corner of Cherry; on Mansfield Avenue, Northeast corner of Loomis.

The 4-inch fire service for the Wells & Richardson Company on Main Street, has been replaced with a 6-inch service.

A 4-inch fire service has been laid for J. R. Booth on the lake front north of the Pumping Station.

Two hydrants, one on North Street east of North Willard, and one on Church Street at Pearl, have been discontinued.

Total number of public hydrants.....	177
Total number of private hydrants.....	28
Total.....	205

SUPPLY PIPE.

Small distribution pipe, less than four inches in diameter, has been laid as follows:

South Prospect Street, southerly from end of Main....	1,200 feet
Archibald Street, easterly from Germain Street.....	70 "
Maple Street, west of R. R. tracks.....	90 "

Total extended.....1,360 feet

There has been discontinued on North Bend Street,

near Voltz..... 271 "

Net increase.....1,089 feet

Total length now in use.....15,708 feet

MAINS.

New mains have been laid as follows:

WITH 30 INCH CAST IRON PIPE.

*In reservoir yard.....	Feet. 202
-------------------------	--------------

WITH 24 INCH CAST IRON PIPE.

*In reservoir yard.....	161
-------------------------	-----

WITH 6 INCH CAST IRON PIPE.

Maple street, westerly from Battery.....	359
Mansfield Avenue, northerly from Loomis.....	450
Loomis, easterly from Mansfield Avenue.....	80

*Charged to current account.

Wilson, westerly from Mansfield Avenue.....	302
Booth, from dead end to North street.....	371
North Bend, at Voltz street.....	271
Johnson street, northerly from Monroe.....	30
	<hr/>
	2026

WITH 4 INCH CAST IRON PIPE.

Maple street blow off.....	43
Center street, northerly from College.....	25
	<hr/>
Total length new mains.....	2094

Cement pipe in the following streets has been replaced :

WITH 16 INCH CAST-IRON PIPE.

Prospect street at Pearl.....	179
College, easterly from Williams street.....	581
Pearl, westerly from Prospect street.....	82

WITH 10 INCH CAST-IRON PIPE.

Willard, from Pearl to College.....	1135
St. Paul, from Pearl to College.....	1281
Williams street, northerly from College.....	40
North Avenue, northerly from Battery Place.....	145

WITH 8 INCH CAST-IRON PIPE.

South Winoski Avenue, Bank to Pearl street.....	652
Pine at Cherry street.....	67
St. Paul street, southerly from College.....	102

WITH 6 INCH CAST-IRON PIPE.

North Avenue, westerly from 10 inch.....	52
Champlain, at Cherry street.....	138

Cherry street, from Winooski Avenue westerly.....	28
Cherry, from Church to Battery.....	1546
North Winooski Avenue, Archibald to First.....	780
Bank to St. Paul.....	75

Total length of cement pipe replaced.....6883

The 4 inch between the hydrant at Buell and Willard streets and the Willard street 10 inch main has been replaced with 6 inch.....	35
Supply pipe in Johnson street at Monroe has been replaced with 6 inch.....	19

Total length pipe replaced.....6937

LENGTH OF PIPE NOW IN USE.

Cement.....	51,106 feet.	9 miles+
Iron.....	141,218 "	26 " +
Total.....	192,324 "	36 " +

GATES.

The following gates have been discontinued :

Prospect street at north line of Pearl.....	1	4 inch.
St. Paul street at College.....	1	4 "
Bank street at St. Paul.....	1	4 "
Cherry street at St. Paul.....	2	3 "
St. Paul street at Pearl.....	1	4 "
Cherry street at Pine.....	2	3 "
Cherry street at Champlain.....	2	3 "
Cherry street at Battery.....	1	4 "
Battery street at Maple.....	1	4 "
Cherry street at Winooski avenue.....	1	3 "
Winooski avenue at Pearl.....	1	4 "

Willard street at College	1	4	inch.
Buell street at Willard	1	4	"
Willard street at Pearl	1	6	"
Williams street at College	1	6	"
Battery Place at Front street	1	6	"

Total number of gates discontinued 19

The following gates have been set :

Reservoir yard	1	24	"
Prospect street at north line of Pearl	1	16	"
Pearl street at west line of Prospect	1	16	"
College street at east line of Williams	1	16	"
Williams street at north line of College	1	10	"
Willard street at north line of College	1	10	"
Willard street at south line of Pearl	1	10	"
St. Paul street at south line of Pearl	1	10	"
St. Paul street at north line of Cherry	1	10	"
St. Paul street at north line of Bank	1	10	"
St. Paul street at north line of College	1	10	"
Front street at north line of Battery Place	1	10	"
Winooski avenue at south line of Pearl	1	8	"
Pine street at south line of Cherry	1	8	"
Pine street at north line of Cherry	1	8	"
Winooski avenue at south line of Cherry	1	8	"
St. Paul street at south line of College	1	8	"
North avenue near Front street branch	1	6	"
Front street north of North avenue branch	1	6	"
Champlain street at north line of Cherry	1	6	"
Champlain street at south line of Cherry	1	6	"
Cherry street at west line of Winooski avenue	1	6	"
Cherry street at west line of Church street	1	6	"
Cherry street at west line of St. Paul street	1	6	"
Cherry street at west line of Pine street	1	6	"

Cherry street at west line of Champlain street...	1	6	inch.
Cherry street at east line of St. Paul street.....	1	6	"
Cherry street at east line of Pine street.....	1	6	"
Cherry street at east line of Champlain street....	1	6	"
Maple street at east line of Battery street.....	1	6	"
Maple street at west line of Battery street	1	6	"
Cherry street at east line of Battery street.....	1	6	"
Winooski avenue at First street.....	1	6	"
Bank street at west line of St. Paul.....	1	6	"
Buell street at west line of Willard.....	1	6	"
Monroe street at east line of Johnson.....	1	6	"
Johnson street at north line of Monroe.....	1	6	"
Wilson street at west line of Mansfield avenue... 1	6	"	
Pearl street on hydrant branch at head of St. Paul	1	6	"
Booth street at south line of North street.....	1	6	"
Loomis street at west line of Mansfield avenue..	1	6	"
Bright street at south line of First street.....	1	6	"
Battery street on blow off at foot of Cherry.....	1	4	"
Maple street on blow off.....	1	4	"
Center street at north line of College.....	1	4	"
North lumber yard on Booth's fire service.....	1	4	"
Interval avenue at south line of Oak street.....	1	4	"
Total added.....	47		
Total now in use.....	541		

REPAIRS.

The repairs for the year have been :

On cement pipe.....	5	breaks.
On cement pipe.....	3	leaks.
On iron pipe	12	leaks.
On service pipes... ..	9	leaks.
On broken hydrants.....	4	
On broken gates.....	4	

METERS.

There are now in use 1,801 meters, an increase of 249 over last year.

Of the water pumped, about 45 per cent has been used through meters, yielding about 70 per cent of the revenue.

The unusually large rain fall of the past year, fifty per cent in excess of that of 1896, which was the direct cause of a shrinkage of about four per cent, in the water receipts, was also the cause of two quite extensive slides on the south and east banks of the old reservoir. Though the embankment opened at the top for fully half the length of each side, the slides fortunately covered a much smaller portion of the slopes.

Repairs were effected without in any way interfering with the use of the reservoir. Both of the low service reservoirs were, as usual, cleaned during the season.

The consumption on the high service, as indicated by the pumping record of that station, was about 12,000,000 gallons or about four per cent of that of the low service. Of this amount ninety-one per cent was measured to consumers through meters, three per cent is estimated to have been used where meters failed to register and in certain cases where it was not expedient to apply meters, and about six per cent only remains unaccounted for.

Since the increased demands upon the high service have rendered imperative the keeping of the motor at all times in perfect repair and the exercise of constant watchfulness over its discharge, it has developed an unexpectedly high efficiency. The auxiliary steam plant has been called upon but five times during the past year. The pumping record of the low service station for the past year is less than for any year since 1890

and is about 55,000,000 less than that for 1893. The machinery is in good repair and while so far as capacity is concerned there is no doubt but that it will be capable of supplying our needs for some time to come, there is no question about the desirability of purchasing in the near future, modern machinery, more economical and of greater capacity.

Biological examinations for the purpose of obtaining information as to the sanitary condition of the supply have been made as usual during the past year. For details relative to this work see the report of Mr. S. C. Prescott of the Massachusetts Institute of Technology, presented herewith.

Samples of water from the pump well and from the low service reservoir have also been examined at the instance of the health department by Dr. Jo H. Linsley, Biologist of the State Board of Health, in search of typhoid germs, of which he found no trace.

Respectfully submitted,

F. H. CRANDALL, Supt.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by U. S. census, 1890, 14,590.

Works constructed 1867-8.

Owned by City.

Source of supply, Lake Champlain.

Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel, $\left\{ \begin{array}{l} b \text{ Bituminous.} \\ d \text{ Clearfield.} \\ e \text{ \$3.85.} \end{array} \right.$
6. Total pumpage for the year, \$282,550,525 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet
Cost of pumping figured on pumping station expenses,
\$8,120.43.
11. Per million gallons raised against dynamic head into reservoir, \$28.73.
12. Per million gallons raised one foot high (dynamic), \$0.09.
Cost of pumping figured on total maintenance, \$49,860.62.
13. Per million gallons raised against dynamic head into reservoir, \$176.46.
14. Per million gallons raised one foot high (dynamic).
\$0.558.

FINANCIAL.

Division I.

MAINTENANCE.

RECEIPTS.	EXPENDITURES.
From Consumers:	AA. Management and repairs. \$39,210 62
A. Water rates, domestic.....\$35,151 38	BB. Interest on bonds..... 10,650 00
B. Water rates, manufacturing 4,189 65	CC. Total maintenance..... 49,860 62
C. Net receipts for water.....\$39,341 03	
D. Miscellaneous..... 2,115 86	
E. Total.....\$41,456 89	
From Public Funds:	
F. Hydrants.....\$3,480 00	
H. Street watering..... 1,778 49	
I. Public buildings	
and parks..... 333 80*	
Watering troughs..... 250 00	
J. General appropriation.....\$5,842 29	
K. Gross receipts from all	
sources.....\$49,860 62	EE. Total.....\$49,860 62

*Paid at meter rates.

Division II.

Division 11.

From fixed rates,	{	L. Domestic .	\$13,494 32
		M. Manufacturing	<u> </u>
		N.	\$13,494 32
From meter rates,	{	O. Domestic ..	\$27,499 35
		P. Manufacturing	4,189 65
		Q.	<u>\$31,689 00</u>
		Total.....	<u>\$45,183 32</u>

CONSTRUCTION.

RECEIPTS.	DISBURSEMENTS.
T. Appropriation... ..\$2,250 00	FF. Extension of Mains.....\$1,775 55
	GG. Extension of services..... 474 45
V. Total.....\$2,250 00	KK. Total.....\$2,250 00
W. Cost of work to date.....	\$459,628 09
X. Bonded debt at date.....	265,000 00
Y.* Value of sinking fund at this date.....	167,145 95

Z. Rate of interest, four per cent.

*Toward paying the entire bonded debt of the
city..... 612,000 00

CONSUMPTION.

1. Estimated total population at date, 17,700.
2. " " " on lines of pipe, 17,300.
3. " " " supplied, 17,100.
4. Total number of gallons consumed for year, 282,550,525.
5. Passed through domestic meters, 104,301,121 gallons, or 36.9 per cent.
6. Passed through manufacturing meters, 21,761,250 gallons, or 7.7 per cent.
7. Average daily consumption, 774,111 gallons.
8. Gallons per day to each inhabitant, 44.
9. Gallons per day to each consumer, 45.
10. Gallons per day to each tap, 247.

DISTRIBUTION.

MAINS.

1. Kind of pipe, cement lined, cast iron, wrought iron.
2. Size from 4 to 30 inches.
3. Extended, 2,094 feet.
4. Discontinued, 6,918 feet.
5. Total now in use, 36 miles.
6. Cost of repairs per mile, \$8.22.
7. Leaks per mile, 0.42.
8. Small distribution pipe less than four-inch, total length, 15,708 feet.
9. Hydrants added, 15.
10. Number now in use, 205.
11. Stop-gates added, 28.
12. Number now in use, 541.
13. Small stop-gates less than four-inch, total, 62.
14. Number of blow-off gates, 12.
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.

SERVICES.

16. Galvanized iron, lead.
17. From one-half to six inches.
18. 2,177 feet.
19. 70 feet.
20. 17 miles or 89,756 feet.
21. Service taps added, 70.
22. Number now in use, 8,137.
23. Average length of services, 30 feet.
24. Average cost of services, \$7.28.
25. Meters added, 249.
26. Number now in use, 1,801.
a. domestic..... 1,752.
b. manufacturing. 49.
27. Motors and elevators added, 3.
28. Number now in use, 33.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons; iron tank, high service, capacity 169,617 gallons.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, }
BOSTON, Mass., Nov. 17, 1897. }

To the Superintendent of Water Works, Burlington, Vt.:

DEAR SIR:—Having been invited for the second time to examine the bacteriological condition of the Burlington water supply as a control upon its sanitary condition, I have the honor to report as follows:

A small room at the motor house was first converted into a laboratory in which the necessary cultivations could be conducted. On account of its convenient location near both reservoirs and the fact that it is supplied with water from both high and low service systems, this room possesses many advantages and might at slight expense be made into an excellent and useful laboratory for the water department. Sterilizers were improvised, also an apparatus for incubating bacteria at the blood heat.

Besides the sanitary examination of the present water supply some time was devoted to a study of the possibility of its pollution from various remote sources. The careful examination of the present supply was, however, regarded as of most importance. Samples were taken from the present intake, the old intake, the pump-well and the tap on the pump at the pumping station, the reservoirs and from taps on both high and low service-pipes in different parts of the city. I also examined samples of sewage and of lake water taken at points near the sewer outfall. By these means it was possible to test not only the sanitary condition of the water as it is

delivered to the consumer but also at a number of places in the course of the water from its entrance to the pipes at Apple Tree intake until it returns to the lake as sewage

The results of these examinations were eminently satisfactory and show that there has been no deterioration in the quality of the water. No evidence of sewage contamination was observed in the water from the present intake or from the pump, but the water from the old intake gave much evidence of pollution, showing again the beneficence of the change by which the intake was removed to Apple Tree reef. These results are regarded with satisfaction as they show that the lake water at the intake is practically pure and that the intake pipe is free from leakage. To show the difference in bacterial contents the following figures, giving the numbers on different days and consequently under different conditions may be of interest :

<i>Source of Water.</i>	<i>Bacteria per c. e.</i>
Apple Tree Reef.....	87
Old Intake.....	875
Apple Tree Reef.....	97
Old Intake.....	910
Apple Tree Reef.....	98
Old Intake.....	1036
Apple Tree Reef.....	52
Old Intake.....	456

The averages of a large number of samples of water from high and low service pipes taken in the city proper gave satisfactory results and attest the good quality of the water as it reaches the consumer. The figures are slightly higher than the average number found at the intake, a condition due apparently to disturbance in the pipes, pump well, etc.

Low service taps.....	116
High service taps.....	119

Some low service samples taken at the outskirts of the city and at the end of a long line of pipe, gave very low results, thus confirming a well-substantiated theory that under some conditions bacteria disappear in the pipes.

A series of tests was made by which I attempted to trace bacteriologically any currents which might flow from the sewer outfall toward the lake front, thus tracing the sewage bacteria after they reach the lake. Samples were collected at the sewer outfall, Champlain Co.'s dock, yacht club and old intake, and from points in the harbor opposite these places at about three-fourths the distance to the breakwater.

The results gave no indication of well-defined currents; the number of bacteria along the lake front diminished gradually as the distance from the sewer outfall increased, while at points more remote from the shore the numbers were very much smaller but still larger than were found at the intake. This might perhaps be regarded as evidence that a slow current, closely following the shore line flows in a northerly direction from the sewer outfall, yet the almost total lack of currents renders the conditions for settling or sedimentation most favorable.

A question having arisen in some quarters as to the possibility of pollution of the water supply from the Winooski River, I made examinations of samples of water collected at a number of different points in the river for the purpose of ascertaining the bacterial condition of the water. As this is a stream which does not receive a large amount of sewage I was not surprised to find that the number of bacteria nominally occurring in the water was small as compared with streams

which are markedly sewage-polluted. Samples were taken at the surface and at a depth of five feet. The results of these analyses as shown in the following table are interesting.

<i>Place.</i>	<i>Surface.</i>	<i>5 ft. depth.</i>
Heineburg Bridge.....	336	480
Grapevine Island.....	345	420
Guoyettes' Bluff.....	272	306
Estuary.....	178	237
Lake at mouth of River.....	194	173

It should be stated that at all the points in the river from which samples were taken the current is slow and the depth but slightly exceeded five feet. Therefore the "deep" samples came from very near the river bottom. The diminution in numbers may be the result of two factors, 1 sedimentation, 2 mixing with the colder and purer water from the lake. The results indicate that the river water is somewhat purified *en route* to the lake, and the possibility of contamination of the Burlington supply from this source may be regarded as very slight.

I have made cultures from the water of the broad lake taking samples from the surface and at various depths down to 75 feet. The water is apparently pure as shown by the character of the organisms. In some cases practically pure cultures of *Bacillus fluorescens liquifaciens*, a species frequently found in the purest of natural waters, were obtained.

The reports of the Health Officer add abundant evidence that the water supply is in a satisfactory condition, only one per cent. of all the deaths recorded for the first nine months of 1897 being from diarrheal diseases, and the number of cases being very small. These reports added to the results of my

investigations lead me to regard the water supply as at present excellent, but it must never be forgotten that the sanitary condition of the water supply depends largely upon the integrity of the intake pipe, and every precaution should therefore be taken to guard against leakages as well as to keep sewage as remote as possible from the intake.

Respectfully submitted,

SAMUEL C. PRESCOTT.

Thirty-Second Annual Report
of the
Water Department
of the
City of Burlington, Vt.
and of the
Water Commissioners
The Tenth.

December 31, 1898.


Burlington :
Prentiss C. Dodge, Printer.
1899.

6

COMPLIMENTS OF

FRANK H. CRANDALL,

SUP'T.

 Please exchange.

Thirty-Second Annual Report
of the
Water Department
of the
City of Burlington, Vt.,
and of the
Water Commissioners
The Tenth.

December 31, 1898.

Burlington :
Prentiss C. Dodge, Printer.
1899.

BOARD OF WATER COMMISSIONERS.

J. E. LANOU, Chairman, (Term expires 1900.)
ALVARO ADSIT, (Term expires 1901.)
JOHN J. FLYNN, (Term expires 1899.)

OFFICERS.

FRANK H. CRANDALL, C. E., Superintendent.
MISS F. P. EADY, Registrar.
MISS K. M. McCAFFREY, Office Assistant.
JOEL W. THOMAS, Engineer at Pumping Station.
WILLIAM CASSIDY, Foreman.
OSCAR HEININGER, Chief Inspector.

TENTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington :

GENTLEMEN :—In compliance with the city ordinance, the Water Commissioners respectfully submit the following, their report for the year ending December 31, 1898.

The receipts from water rates for the year have been \$45,958.84, a slight increase over those of 1897. The amount of the unpaid bills is also slightly in excess of that reported a year ago.

There is this year, as there has been for a number of years, a large amount charged to current expense which, though perhaps properly chargeable to this account, was in no sense a necessary expense of maintenance.

Though the pumpage for the year has been about twelve million in excess of that of the year previous, it still falls more than ten million short of any of the years immediately preceding. The average daily consumption for the year, 805,800 gallons, about 100,000 gallons less than that of five years ago, has required an average daily run of less than ten hours.

The pumping machinery has not cost more than usual for repairs, is in excellent condition and as capable of efficient service as it ever was.

The above fact constitutes no argument against more economical and efficient machinery.

We would renew our previous recommendations relative to the setting of boundary posts, and the prohibition of encroachment upon the low service premises and right of way.

The recent lumber yard conflagration, at which nine hydrants were used, and on account of which about six million gallons of water, or more than enough to supply the average demand for a week was pumped, furnished an excellent testimonial as to the ability of the water works to maintain a good fire pressure in time of heavy draft in that locality.

Biological examinations of the supply were made as usual during the season, and with the usual satisfactory result.

For details of the season's work and expenditures, reference is made to the accompanying report of the Superintendent.

Respectfully submitted,

J. E. LANOU,	} Water	
A. ADSIT,		} Commissioners.
JOHN J. FLYNN,		

THIRTY-SECOND ANNUAL REPORT OF THE SUPERINTENDENT OF WATER WORKS.

*To the Honorable Board of Water Commissioners of the City
of Burlington, Vt. :*

GENTLEMEN:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1898.

FUNDS AVAILABLE FOR THE USE OF THE DEPARTMENT.

App. by charter for current expenses-----	\$42,924 16
“ “ “ “ sinking fund-----	2,259 16
From sales of material, permits, etc-----	637 64
	<hr/>
Total for current expense and sinking fund	\$45,820 96
Appropriation for construction-----	3,500 00
	<hr/>
Total funds available-----	\$49,320 96
Drawn -----	49,306 18
	<hr/>
Unexpended -----	\$ 14 78

SINKING FUND.

Since the enactment of the amendment to the city charter requiring that “A sum not less than five per cent. of the amount of the gross receipts from all sources derived from the use of water for the year ending the 31st of December of the year previous shall be placed to the credit of the sinking fund to be applied in the reduction of the bonded and other indebtedness of the city incurred for the benefit of the water

department," deposits have been made with the City Treasurer as follows :

September 10, 1897-----	\$2,360 25
August 4, 1898-----	2,259 16

RECEIPTS.

From L. C. Grant, City Treasurer-----	\$49,306 18
---------------------------------------	-------------

DISBURSEMENTS.

Construction :

Cast iron pipe-----	\$ 1,018 84
Labor on mains-----	1,394 10
Gates -----	282 91
Hydrants -----	150 00
Gate and cut off boxes-----	112 90
Lead and yarn-----	41 00
Material for services-----	95 47
Labor on services-----	390 00
	<hr/>
	\$ 3,485 22

Current Expenses :

Interest -----	\$ 10,365 00
Pay-rolls -----	3,757 66
Salary of Superintendent-----	1,200 00
Care and repair of reservoirs and resident premises-----	958 13
Tank cleaning and repairs-----	664 13
Material for management and repairs	638 95
Horse keeping, shoeing, repairs and barn rent-----	514 93
City of Burlington, other departments	446 60
Salary of Registrar -----	400 00
Salary of Water Commissioners-----	300 00
Castings-----	300 00

WATER DEPARTMENT.

7

Plumbers' bills-----	253 94
Printing, advertising and postage---	239 64
Hydrant repairs-----	228 56
Fuel and light for office and shop----	202 98
Corporation stops and brass goods---	150 68
Tools -----	130 28
Repair of tools-----	129 85
Freight and express charges-----	90 74
Telephone rent-----	78 00
Six ton Fairbanks scales-----	75 00
Office expenses-----	56 64
Biological examinations of supply---	50 00
Damages -----	38 24
Replaced cement pipe with cast iron.	
Cast iron pipe-----	\$4,354 03
Lead and yarn-----	745 48
Water gates-----	341 75
Labor -----	5,197 51
	<hr/> \$10,638 77
	<hr/> \$31,908 72

Pumping Division :

Fuel -----	\$ 3,299 70
Pay rolls-----	2,471 31
Repairs to buildings and grounds----	1,234 64
Supplies-----	264 79
Repairs to machinery -----	138 93
Repairs to motor-----	64 84
Damper regulator-----	56 00
	<hr/> \$ 7,530 21

Meter Division :

Meters -----	\$ 2,391 90
Pay-rolls -----	1,521 69
Repairs and freight-----	209 28
	<u> </u> \$ 4,122 87

Sinking Fund :

L. C. Grant, Treasurer-----	\$ 2,259 16
	<u> </u> \$ 2,259 16

RECAPITULATION.

Construction-----	\$ 3,485 22
Sinking fund-----	2,259 16
Current-----	\$31,908 72
" Pumping-----	7,530 21
" Meter -----	4,122 87
	<u> </u> 43,561 80
	<u> </u> \$49,306 18

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates-----	\$11,841 39
Meter rates-----	34,117 45
	<u> </u> \$45,958 84

DISBURSEMENTS.

L. C. Grant, City Treasurer-----	\$45,958 84
----------------------------------	-------------

We, the undersigned, have examined the books and vouchers for the year 1898 of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

GEO. W. BECKWITH,	} Auditors.
JOHN C. FARRAR,	
THOMAS FAILEY,	

Statement of assessments and current expenditures for year ending December 31, 1898.

ASSESSMENTS.		EXPENDITURES.	
PAID.			
Meter rates...	\$34,103 60	Interest.....	\$10,365 00
Sched. rates..	11,803 29	Repl'g cement pipe.....	10,638 77
	\$45,906 89	Current.....	\$10,904 95
Mat. & Labor.	583 22—46,490 11	Pumping.....	7,530 21
		Meters.....	4,122 87
			—22,558 03
			\$43,561 80
UNPAID.			
Meter rates...	\$ 47 20	Excess of assessments	
Sched. rates..	60 37	To Sink'g fund	2,259 16
	107 57	" City Treas..	938 89
Mat. & Labor.	162 17 \$ 269 74	Total excess..	\$ 3,198 05
	\$46,759 85		\$46,759 85

WATER PUMPED.

1898.	Gallons.
January.....	20,110,025
February.....	18,098,300
March.....	20,332,550
April.....	21,653,300
May.....	23,783,625
June.....	29,751,075
July.....	31,622,350
August.....	27,381,775
September.....	26,948,850
October.....	23,138,725
November.....	24,538,575

December-----	26,759,200
Total, 1898-----	294,118,350
Total, 1897-----	282,550,525
Increase in 1898-----	11,567,825
Daily average in 1898-----	805,800
Daily average in 1897-----	774,111

SERVICES.

There have been added 67 services of the following sizes :

Sixty-two-----	$\frac{1}{2}$ inch.
One-----	$\frac{3}{4}$ "
Two-----	1 "
One-----	$1\frac{1}{2}$ "
One-----	4 "

Of the above, three services, two for the Bradley property on South Union street and one for the Warner estate on Church street, were laid prior to street improvement without application from the owner of the premises to be supplied and are not as yet in use. Eleven services have been replaced, seven on account of street improvement, and four for other causes.

Two services were discontinued prior to laying the brick roadway on Church street.

HYDRANTS.

Two post hydrants have been added, one on North Bend street near Crowley, and one on Henry street at Weston.

Five hydrants have been discontinued, four in the rail-

road yard and one at corner of Briggs street and Lyman avenue.

Total number of public hydrants-----174

Total number of private hydrants----- 31

205

SUPPLY PIPE.

No pipe of less than four inch diameter has been laid during the past season.

Supply pipe has been discontinued as follows:

North Bend St., between North avenue and Volz 640 feet.

North street from North Willard to Prospect----- 1,070 "

Ward street, easterly from Blodgett----- 60 "

Discontinued----- 1,770 "

Total length now in use-----13,938 "

MAINS.

New mains have been laid as follows :

WITH 6 INCH CAST IRON PIPE.

Feet.

First street, from Oak to Bright----- 383

Mansfield avenue, northerly from dead end----- 120

North Bend street, between North avenue and Pitkin--1,080

Bradley street, easterly from South Union----- 21

South Union street, from College to Main----- 405

Champlain street, from College to Main----- 350

Greene street, southerly from Hickok----- 104

Center street, from College street northerly----- 120

Kilburn street, from dead end to St. Paul----- 323

Drew street, from Ward southerly----- 57

Hydrant branch and fire service at the pumping station-----	58
Ward street, from North Bend to Blodgett-----	149
Pitkin street, from dead end to North Bend-----	125
	<hr/>
	3,295

WITH 4 INCH CAST IRON PIPE.

	Feet.
Ward street, connecting dead end-----	366
Luck street, from Interval avenue westerly-----	254
Orchard terrace, dead end southerly-----	38
	<hr/>
	658

Total length new mains-----3,953

Cement pipe in the following streets has been replaced :

WITH 12 INCH CAST IRON PIPE.

	Feet.
North street, from Willard to Prospect-----	1,070

WITH 10 INCH CAST IRON PIPE.

South Union street, from Howard to St. Paul-----	858
--	-----

WITH 8 INCH CAST IRON PIPE.

North Winooski avenue, from Pearl to Grant-----	588
---	-----

WITH 6 INCH CAST IRON PIPE.

First street, from Bright to Winooski avenue-----	696
South Champlain street, between Maple and Pearl-----	1,827
Maple street, from Battery to Champlain-----	304
Bank street at Champlain-----	79
Lafountain street, from Cedar to North Bend-----	700
Beach street, easterly from South Union-----	49
North Bend street, from Lafountain to Rose-----	470
Rose street, from North Bend to North-----	1,064

Cedar street at Rose-----	95
Bright street at First-----	37
Total length replaced-----	7,837

LENGTH OF PIPE NOW IN USE.

Cement-----	43,269 feet.	8 miles+
Iron-----	153,008 "	29 " +
Total-----	196,267 "	37 " +

GATES.

The following gates have been discontinued :

Oak street at Interval avenue-----	1	4	inch.
First street at Winooski avenue-----	1	4	"
Bank street at Champlain-----	2	3	"
Champlain street at College-----	1	6	"
North street at North Willard-----	1	4	"
Maple street at Champlain-----	1	4	"
Beech street at South Union-----	1	4	"
North street at Prospect-----	1	3	"
North street at east line of Willard,-----	1	10	"
South Union street at St. Paul-----	1	6	"
North Winooski avenue at south line of Grant	1	4	"
Grant street at Winooski avenue-----	2	3	"
Rose street at North Bend-----	1	3	"
Cedar street west of Rose-----	1	4	"
Lafountain street at North Bend-----	1	4	"
Total discontinued-----	17		

The following gates have been set :

North street east line of North Willard-----	1	12	inch.
--	---	----	-------

College street at east line of Pearl-----	I	10	inch.
South Union street at St. Paul-----	I	10	"
Church street at south line of Cherry-----	I	8	"
North Winooski avenue at Grant-----	I	8	"
First street at west line of Winooski avenue--	I	6	"
First street at east line of Bright-----	I	6	"
First street at west line of Bright-----	I	6	"
First street at east line of Interval avenue-----	I	6	"
Oak street at west line of Interval avenue-----	I	6	"
South Champlain at south line of Maple-----	I	6	"
South Champlain at north line of Maple-----	I	6	"
South Champlain at south line of College-----	I	6	"
South Champlain at north line of College-----	I	6	"
South Champlain at south line of Bank-----	I	6	"
South Champlain at north line of Bank-----	I	6	"
Maple street at west line of South Champlain--	I	6	"
Bank street at east line of South Champlain--	I	6	"
Bank street at west line of South Champlain--	I	6	"
Lafountain street at south line of North Bend--	I	6	"
North Bend street at north line of Ward-----	I	6	"
" " " " west " Rose-----	I	6	"
" " " " east " "-----	I	6	"
" " " " west " Lafountain	I	6	"
" " " " east " "	I	6	"
Rose street at south line of North Bend-----	I	6	"
" " " north " Cedar street east--	I	6	"
" " " south " " "-----	I	6	"
Cedar street at east line of Rose-----	I	6	"
Cedar street at west line of Rose-----	I	6	"
Bright street at south line of First-----	I	6	"
Mansfield avenue at south line of North-----	I	6	"

Bradley street at east line of South Union----	I	6	inch.
South Union street at north line of Main-----	I	6	"
Greene street at south line of Hickok-----	I	6	"
Kilburn street at west line of St. Paul-----	I	6	"
Drew street at south line of Ward-----	I	6	"
Beech street at east line of South Union-----	I	6	"
Ward street at east line of Blodgett-----	I	6	"
Pitkin street at south line of North Bend-----	I	6	"
Pumping Station Yard Fire Service-----	I	6	"
Pumping Station Yard Hydrant branch-----	I	6	"
Ward street at west line of Blodgett-----	I	4	"
Luck street at west line of Interval avenue----	I	4	"
Luck street 254 feet west of Interval avenue--	I	4	"
Grant street at west line of Winooski avenue--	I	4	"
Grant street at east line of Winooski avenue--	I	4	"
Union street north of Adams street branch----	I	4	"
Kilburn street on fire service for V. B. Co.----	I	4	"
<hr/>			
Total added-----	49		
Total now in use-----	573		

REPAIRS.

The repairs for the year have been :

On cement pipe-----	7	breaks.
On cement pipe-----	2	leaks.
On iron pipe-----	7	"
On service pipes-----	11	"
On broken hydrants-----	6	
On broken gates-----	2	

HIGH SERVICE.

The consumption on the high service, as indicated by

the pumping record of that station, was about twelve and one-half million gallons, or about 4 per cent of that of the low service. Of this amount about $86\frac{3}{4}$ per cent was measured to consumers through meters, one-fourth of one per cent was estimated to have been used where meters stopped and where it was inexpedient to apply meters, five per cent was the estimated loss in the motor and about eight per cent only remains unaccounted for.

It did not become necessary to use the auxiliary steam plant at the high service station, except during the cleaning and repair of the tank, and but about one and one-half per cent of the high service supply was pumped by steam.

METERS.

There are now in use 1,963 meters, an increase of 162 over last year.

Of the water pumped, 46 per cent has passed through meters yielding 74 per cent of the revenue.

Respectfully submitted,

F. H. CRANDALL.

BURLINGTON, Vt., Oct. 3, 1898.

Mr. F. H. Crandall, Supt. Burlington Water Works, City :

DEAR SIR :—At your request I have made a careful bacteriological examination of the water supply of this city with results as given below. The work extended through the months of August and September. Specimens were taken from thirty (30) different places as indicated in the tabulation.

SOURCE OF SPECIMEN.	NO. OF BACTERIA TO CENTIMETER.
10 feet north main sewer outlet-----	6740
50 feet off Champlain Transportation Co.'s wharf-----	1165
50 feet from mouth of main sewer-----	550
Faucet—house of J. H. Linsley—South Union street----	224
Off dock at pumping station-----	205
Office Lang & Goodhue, Park avenue-----	200
Shelburne reef buoy-----	190
100 feet east of breakwater, opposite Lake Champlain Yacht Club wharf-----	181
Laboratory Hayward Block, Main street-----	175
Tap in pumping station-----	170
Tap Mary Fletcher Hospital-----	160
North reservoir-----	160
100 feet east of breakwater, opposite Champlain Trans- portation Co.'s wharf-----	154
Higher service, tap in motor house-----	146
50 feet off Lake Champlain Yacht Club wharf east-----	145
Faucet—Lake Champlain Yacht Club house-----	132
100 feet east of breakwater, opposite Maple St. wharf----	132
50 feet west of south wharf-----	126
Off dock—Lake Champlain Yacht Club wharf-----	121
Office Lang & Goodhue (first drawn)-----	119
50 feet off south end breakwater-----	114
South reservoir-----	110
Higher surface reservoir-----	104
300 feet off south end Linsley slip, west-----	92
Appletree reef (intake)-----	66
Rock Point Institute—faucet in kitchen-----	66
Faucet—car barn—North Winooski avenue-----	63
Off north end breakwater-----	55

200 feet west of pumping station-----	44
300 feet west of W. & D. G. Crane's mill-----	37

Water containing not over 300 micro-organisms to the cubic centimeter is considered perfectly safe for domestic use *provided* of course, that the bacteria are of the varieties usually found in water, and not those of a pathogenic nature. None of these latter (or disease germs) were found in the water supply of this city.

The specimens of water collected from the lake were taken during various conditions of temperature and wind, and, I believe, represent a fairly accurate average condition of the water at the different localities.

Examination of the table above given will show the excellent character of the water supplied to our citizens.

Respectfully submitted,

JO H. LINSLEY, M. D.

SUMMARY OF STATISTICS.**SUGGESTED BY THE
NEW ENGLAND WATER WORKS ASSOCIATION.**

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by U. S. census, 1890, 14,590.

Works constructed 1867-8.

Owned by City.

Source of supply, Lake Champlain.

Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel. $\left\{ \begin{array}{l} b \text{ Bituminous.} \\ d \text{ Reynoldsville.} \\ e \text{ \$2.67}\frac{1}{2}. \end{array} \right.$
3. Total pumpage for the year, 294,118,350 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet. Cost of pumping figured on pumping station expenses, \$7,530.21.
11. Per million gallons raised against dynamic head into reservoir, \$25.61.
12. Per million gallons raised one foot high (dynamic), \$0.08. Cost of pumping figured on total maintenance, \$43,561.80.
13. Per million gallons raised against dynamic head into reservoir, \$148.13.
14. Per million gallons raised one foot high (dynamic) \$0.468.

FINANCIAL.

Division I. MAINTENANCE.

RECEIPTS.	EXPENDITURES.
From Consumers:	AA. Management and repairs.
A. Water rates, domestic.....\$37,241 45	Repl. cement.....\$10,638 77
B. Water rates, mfg.....2,874 41	Current expenses 10,004 95
C. Net receipts for water.....40,115 86	Pumping " 7,530 21
D. Miscellaneous.....637 64	Meter " 4,122 87
E. Total.....\$49,753 50	BB. Interest on bonds and notes.....10,365 00
From public funds:	CC. Total maintenance.....\$43,561 80
F. Hydrants.....\$3,180 00	DD. Bal. to Sinking Fund.....2,360 25
H. Street watering*.....1,577 28	Bal. to City Treas. 674 43
I. Public buildings and parks*.....235 70	Total balance.....3,034 65
Watering troughs.....280 00	EE. Total.....\$46,596 48
K. Gross receipts from all sources.....\$46,986 48	

* Paid at meter rates.

Division II.

From fixed rates.	L. Domestic-----\$11,841 39
	M. Manufacturing -----
From meter rates.	N. -----\$11,841 39
	O. Domestic-----\$31,243 04
	P. Manufacturing 2,874 41
	Q. -----\$34,117 45
	Total-----\$45,958 84

CONSTRUCTION.

RECEIPTS.	DISBURSEMENTS.
T. Appropriation.....\$3,485 22	FF. Extension of mains.....\$2,809 75
V. Total.....\$3,485 22	GG. Extension of services.....585 47
	KK. Total.....\$3,485 22

W. Cost of work to date-----	\$463,113 31
X. Bonded debt at date-----	258,500 00
Y.* Value of sinking fund at this date-----	181,572 88
Z. Rate of interest, four per cent.	

*Toward paying the entire bonded debt of the city, 754,000 00

CONSUMPTION.

1. Estimated total population at date, 18,000.
2. " " " on lines of pipe, 17,600.
3. " " " supplied, 17,400.
4. Total number of gallons consumed for year, 294,118,350.
5. Passed through domestic meters, 120,979,500 gallons, or 41 per cent.
6. Passed through manufacturing meters, 14,785,500 gallons, or 5 per cent.
7. Average daily consumption, 805,800 gallons.
8. Gallons per day to each inhabitant, 45.
9. Gallons per day to each consumer, 46.
10. Gallons per day to each tap, 251.

DISTRIBUTION.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Galvanized iron, lead.
2. Size from 4 to 30 inches.	17. From one-half to six inches.
3. Extended, 3,833 feet.	18. 1,800 feet.
4. Discontinued, 7,837 feet.	19. 60 feet.
5. Total now in use, 37 miles.	20. 17 miles or 91,556 feet.
6. Cost of repairs per mile, \$8.50.	21. Service taps added, 67.
7. Leaks per mile, 0.22.	22. Number now in use, 3,202.
8. Small distribution pipe less than four-inch, total length, 13,938 feet.	23. Average length of services, 27 feet.
9. Hydrants added, 2.	24. Average cost of services, \$7.60.
10. Number now in use, 205.	25. Meters added, 162.
11. Stop-gates added, 49.	26. Number now in use, 1,963.
12. Number now in use, 573.	a. domestic. 1,926
13. Small stop-gates less than four-inch, total, 56.	b. manufacturing. 37
14. Number of blow-off gates, 12.	27. Motors and elevators, added, 2.
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.	28. Number now in use, 35.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons; iron tank, high service, capacity 169,617 gallons.

THIRTY-THIRD ANNUAL REPORT



OF THE

Water Department

OF THE

City of Burlington, Vt.,

AND OF THE

WATER COMMISSIONERS

THE ELEVENTH.

January 1, 1900.

BURLINGTON :
FREE PRESS ASSOCIATION,
PRINTERS, BINDERS AND STATIONERS.
1900.

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PRINTERS, BINDERS AND STATIONERS.
1900.

BOARD OF WATER COMMISSIONERS.

J. E. LANOU, Chairman, (Term expires 1900).

ALVARO ADSIT, (Term expires 1901).

JAMES E. MEAGHER, (Term expires 1902).

OFFICERS.

FRANK H. CRANDALL, C. E., Superintendent.

Miss F. P. EADY, Registrar.

Miss K. M. McCaffrey, Office Assistant.

JOEL W. THOMAS, Engineer at Pumping Station.

WILLIAM CASSIDY, Foreman.

OSCAR HEININGER, Chief Inspector.

ELEVENTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

GENTLEMEN:—In compliance with the city ordinance, the Water Commissioners respectfully submit the following, their report for the year ending December 31, 1899.

The receipts from water rates for the year have been \$48,782.71, an increase of \$2,823.87 over the receipts of last year. The amount of the unpaid bills for water, \$78.72, is the least ever reported and stands, for the most part, against parties, the appearance of whose names on such a list is unnecessary and would, to the average observer, be unexpected.

A careful and impartial enforcement of the regulations, relative to collection during the past three years, has uniformly resulted in the collection, within fifteen days, of about ninety-five per cent of the rates for the period.

We find that a strict compliance with the instructions in regard to the collection of water taxes contained in the water ordinance, affords ample opportunity for the exercise of judgment.

The water supply is now off for non-payment in three places only, and none of the bills carried forward to 1900 can be regarded as at all doubtful of collection.

A statement in regard to the enforcement of health regulations made at a recent meeting of Vermont Health

Officers, "An impartiality that, recognizing neither position nor influence, serves everyone alike, the people will respect," impresses us as equally true of regulations in regard to the collection of water rates.

Our experience confirms this impression, as well as convinces us, that the laying down of definite instructions, as is the case in the water ordinance, only in regard to matters upon which the exercise of judgment is neither desired nor permitted, is conducive to generally satisfactory results.

The amount required by the charter to be deposited to the sinking fund will, with accumulations at three per cent. in fifty years, exceed in amount the present indebtedness of the city incurred for the department.

Beside the \$2,297.94, five per cent of the appropriation required to be deposited to the credit of the sinking fund and \$2,726.42 transferred to the construction account to cover the necessary extensions of the past season, \$5,531.17 has been deposited to the sinking fund.

In view of the large amount of work before the department in replacing small supply pipes with larger fire protective mains, the preparation of the distribution system for the advent of pumping machinery of larger capacity and the installation of a new pumping plant, it would seem that, as soon as materials can be obtained advantageously, the surplus funds of the water department should be devoted to these latter purposes.

We do not mean by the above to object in the least to the moderate reduction of revenue incident to the small discount for cash, for which our water takers have, for sometime, been asking, and which it has been our desire to see granted as soon as conditions should warrant it.

The indicated pumpage for the year, about 309,000,000 gallons, while about 15,000,000 in excess of that of 1898, stills falls about 28,000,000 short of that of 1893.

The pumping machinery is in excellent condition, the repairs to the buildings necessitated by the fire of 1894 have been completed, and the grounds, as opportunity offers, are being graded and improved.

Stone posts, marking the boundaries of the lot and right of way, mentioned in the recorded description of the premises, have, with the exception of one at the intersection of the north line of the right of way with the west line of Lake Street, been set and marked by Mr. H. M. McIntosh, City Engineer, and Mr. Ford, the Engineer of the Railroad Company.

Numerous biological and chemical examinations of the city water have been made during the year at the Laboratory of the State Board of Health, at the expense of the State of Vermont. We regret our inability to secure of Dr. Linsley, at this time, a report in regard to this valuable work.

A comparison of the results of the past year, with those of former years, serves to corroborate the general impression that our excellent supply is suffering no impairment.

For tabulated statement of biological and chemical examinations, as also for other details of the season's work and expenditures, reference is made to the accompanying report of the Superintendent.

Respectfully submitted,

J. E. LANOU,	{	Water Commissioners.
A. ADSIT,		
JAS. E. MEAGHER.		

THIRTY-THIRD ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS.

To the Honorable Board of Water Commissioners of the City of Burlington, Vt. :

GENTLEMEN :—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1899.

FUNDS AVAILABLE FOR THE USE OF THE DEPARTMENT.

App. provided by charter for current expenses . . .	\$43,660 90
“ “ “ “ “ sinking fund	2,297 94
From sales of pipe, permits, &c.	1 533 36
	<hr/>
	\$47,492 20

SINKING FUND.

Since the enactment of the amendment to the city charter requiring that “ A sum not less than five per cent. of the amount of the gross receipts from all sources derived from the use of water for the year ending the 31st of December of the year previous shall be placed to the credit of the sinking fund to be applied in the reduction of the bonded and other indebtedness of the city incurred for the benefit of the water department,” deposits have been made with the City Treasurer as follows :

WATER DEPARTMENT.

7

September 10, 1897, 5 per cent. required by charter	\$2,360 25
August 4, 1898, " " " " "	2,259 16
August 10, 1899, " " " " "	2,297 94
November 9, 1899, surplus funds.....	4,000 00
December 31, 1899, " "	1,531 17

RECEIPTS.

From L. C. Grant, City Treasurer :

Amt. of appropriations for current ex-

penses\$43,660 90

" of appropriations for sinking fund 2,297 94

Total amount of appropriations.....\$45,958 84

Sales of material, permits, &c..... 1,533 36

Transfer from current to construction account 2,726 42

\$50,218 62

DISBURSEMENTS.

Construction:

Cast iron pipe.....\$1,214 94

Labor on mains 824 62

Hydrants..... 136 50

Packing..... 14 98

Material for services.....\$41 27

Labor on services.....494 11 535 38

Total construction..... \$2,726 42

MAINTENANCE.

Current :

Pay-rolls \$ 3,701 51

Salary of Superintendent..... 1,200 00

Care and repair of reservoir, banks

and grounds..... 693 44

Horse keeping, shoeing, repairs and

Barn rent	525	58	
Material for management and repairs.	447	59	
City of Burlington, other departments	437	16	
Salary of Registrar	400	00	
Brass goods	338	25	
Castings	318	79	
Salary of Water Commissioners	300	00	
Tank cleaning and repairs	284	73	
Pipe and fittings	254	99	
Hydrant repairs	247	08	
Printing, advertising and postage	171	15	
Repair of tools	90	14	
Testing intake	84	46	
Office expenses	78	97	
Telephone rent	78	00	
Thawing services	46	74	
Damages	43	71	
Gas for office and shops	34	94	
Care and repair of private telephone line	32	16	
By order of the Board of Aldermen :			
W. P. & L. D. Clark	\$ 27	71	
E. M. Sutton	21	31	49 02
			\$ 9,858 41
<i>Replacing of cement pipe with cast-iron :</i>			
Cast-iron pipe	\$ 2,110	40	
Gates	1,021	28	
Labor	3,181	73	
Lead and yarn	961	81	
			\$ 7,275 22
<i>Interest .</i>			
Interest on debt			10,080 00

WATER DEPARTMENT.

9

Pumping :

Pay rolls.....	\$ 2,061 43
Repairs of buildings and grounds.....	1,792 27
Fuel.....	1,218 00
Supplies.....	210 90
Repairs to machine.....	110 20
Feed pump.....	69 48
Lights.....	41 12

High Service Station.

Repairs to building.....	\$ 127 21
Repairs to steam pump.....	210 06
Pay rolls for steam pump....	180 59
Repairs to motor.....	10 95
Pay rolls for motor.....	86 91
Lights.....	12 27
	<u>627 99</u>
	\$ 6,131 39

Meters :

Pay rolls.....	\$ 1,498 54
Meters.....	1,882 13
Freight and repair bills.....	210 98
	<u>\$ 3,591 65</u>

Total maintenance.....\$36,936 67

TRANSFERS.

To sinking fund.....	\$ 7,829 11
To construction account....	<u>2,726 42</u>
Total transfers.....	<u>\$ 10,555 53</u>
Total disbursements.....	\$ 50,218 62

RECAPITULATION.

Receipts from L. C. Grant, City Treasurer.....\$50,218 62

DISBURSEMENTS :

Transfer to construction....	\$2,726 42
Transfer to sinking fund....	7,829 11
Total transfers	\$10,555 53
Construction	2,726 42
Current	\$9,858 41
Replacing	7,275 22
Pumping	6,131 39
Meters	3,591 65 26,856 67
Interest... ..	10,080 00
Total maintenance.....	\$36,936 67
Total disbursements.....	\$50,218 62

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates.....	\$10,952 11
Meter rates.....	37,830 60
Total receipts.....	\$48,782 71

DISBURSEMENTS.

L. C. Grant, City Treasurer	\$48,782 71
-----------------------------------	-------------

UNPAID WATER RATES.

Schedule rates, nine in number	\$28 96
Meter rates, nine in number	49 76
Total unpaid Water rates forward to 1900....	\$78 72

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1899 of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

We also find that the provision of the water ordinance, relative to penalty for failure to pay promptly, has been fairly and impartially enforced.

GEO. W. BECKWITH, }
JOHN C. FARRAR, } Auditors.
THOMAS FAILEY, }

Statements of assessments and current expenditures for year ending December 31, 1899.

ASSESSMENTS.		DISBURSEMENTS.	
PAID.		Interest.....\$10,030 00	
Meter rates.....	\$37,773 00	Replacing cement pipe....	7,275 22
Schedule rates.....	10,881 81	Current.....	\$9,858 41
		Pumping.....	6,131 39
	\$48,654 81	Meters.....	3,591 65 19,581 45
Mat. and labor	1,313 92 \$49,968 73	Total current exp.....	\$36,936 67
UNPAID.		Excess of assessments.	
Meter rates.....	\$46 66	To Sinking fund	\$7,829 11
Schedule rates.....	28 96	" Construction	2,726 42
	\$75 62	" City Treas'r	2,605 54
Material and labor	53 39 \$129 01	Total excess.....	\$13,161 07
	\$50,097 74		\$50,097 74

WATER PUMPED.

1899.	allons.
January	21,623,575
February	20,632,700
March.....	22,726,750

April.....	22,601,600
May.....	28,087 725
June.....	29,354,950
July.....	32,539,575
August.....	32,968,025
September.....	26,986,775
October.....	26,419,525
November.....	23,789,575
December.....	21,181,750
Total, 1899.....	308,912,525
Total, 1898.....	294,118,350
Increase in 1899.....	14,794,175
Daily average in 1899.....	846,335
Daily average in 1898.....	805,800

SERVICES.

There have been added 98 services of the following sizes :

Eighty-three.....	$\frac{1}{2}$ inch.
Eight.....	$\frac{3}{4}$ "
Three.....	1 "
One.....	2 "
One.....	4 "
Two.....	6 "

Of the above, two services, one for No. 16 Cedar Street and one for No. 12 Poplar Street, were put in at the time when new mains were laid in those streets, and are not as yet in use, and five replace six old services. Besides the six services, which have been replaced, two, one for the grist mill barn on Colchester Avenue and one for No. 9 North Champlain Street, eight in all, have been discontinued.

HYDRANTS.

Three public fire hydrants have been added, one on King Street west of the tracks, one in the lumber yard north of Crane's Mill, and one at the intersection of Harrison and Central Avenues.

Five private hydrants have been added on the premises of the Queen City Cotton Company.

Total number of public hydrants..... 177

Total number of private hydrants..... 36

213

SUPPLY PIPE.

One inch galvanized iron distribution pipe has been laid as follows :

Central Avenue, southerly from Harrison Avenue.. 195 feet.

Harrison Avenue, easterly from Conger Avenue:... 130 "

Wright Avenue, easterly from Central Avenue..... 117 "

Total addition..... 442

Total now in use..... 14,380

Forty-four feet of one inch supply pipe in Myrtle Street, easterly from the Battery Street main, was, during the progress of the work on that street preparatory to road improvement and sewer extension, replaced with two inch galvanized iron pipe.

About seventy-five feet of one inch supply pipe at the east end of Mechanic's street was replaced with new galvanized iron pipe prior to the concreting of the street.

MAINS.

New mains have been laid as follows :

WITH 6 INCH CAST IRON PIPE.		feet.
Drew street, southerly from Ward.....	215	
Buell street, westerly from Union	220	
Orchard Terrace, northerly from Buell	41	
King street, westerly from dead end ..	488	
Wilson street from Prospect, easterly to dead end.....	190	
Loomis street from Prospect street main to east line of Prospect.....	33	
Brookes avenue from Prospect street, westerly	379	
Henry street from Prospect street main to west line of Prospect.....	17	
Harrison avenue from Central, easterly.....	330	
Conger avenue from dead end, southerly to Harrison ...	391	
		<hr/> 2304
WITH 4 INCH CAST IRON PIPE.		
Oak street from Luck, westerly to dead end...	62	
Luck street from St. Louis street main to east line of St. Louis.....	18	
St. Louis street from Oak, northerly to dead end.....	212	292
		<hr/>
Total length of new mains.....		2596

Cement pipe in the following streets has
been replaced :

WITH 16 INCH CAST IRON PIPE.	
Prospect street from Pearl to North.....	1507

WITH 12 INCH CAST IRON PIPE.

North street at Prospect..... 97

WITH 8 INCH CAST IRON PIPE.

Battery street from North to North Bend..... 993

WITH 6 INCH CAST IRON PIPE.

Poplar street from Battery to Champlain..... 418

Champlain street from Cedar to Poplar..... 215

Cedar street from Champlain to Rose..... 265

Lumber Yard, northerly from Crane's office... 865

Total length replaced..... 4360

LENGTH OF PIPE NOW IN USE.

Cement 38,909 ft. 8 miles

Iron..... 159,964 " 30 "

Total 198,873 " 38 "

GATES.

The following gates have been discontinued :

Poplar street at Champlain..... 1 4 inch

Prospect street at North..... 1 4 "

Loomis street at Prospect..... 1 4 "

Lumber Yard north of Crane's..... 1 6 "

Total discontinued..... 4

The following gates have been set :

Prospect street at south line of North..... 1 16 "

Prospect street at south line of Loomis..... 1 16 "

Prospect street at north line of Loomis	1	16	inch
North street at east line of Prospect....	1	12	"
North street at west line of Prospect.....	1	12	"
In South Reservoir.....	1	10	"
Battery street at south line of North Bend....	1	8	"
Battery street at south line of Poplar.....	1	8	"
Battery street at north line of Poplar.....	1	8	"
Poplar street at east line of Battery.....	1	6	"
Poplar street at west line of Champlain.....	1	6	"
Champlain street at north line of Poplar.....	1	6	"
Champlain street at south line of Poplar.....	1	6	"
Champlain street at south line of Cedar.....	1	6	"
Cedar street at east line of Champlain.....	1	6	"
Drew street at north line of Strong.....	1	6	"
Buell street at east line of Orchard Terrace...	1	6	"
Buell street at west line of Union.....	1	6	"
Orchard Terrace at north line of Buell.....	1	6	"
Henry street at west line of Prospect	1	6	"
Wilson street at east line of Prospect.....	1	6	"
Brookes avenue at west line of Prospect.....	1	6	"
Conger avenue at north line of Harrison avenue	1	6	"
Harrison avenue at east line of Conger avenue	1	6	"
Harrison avenue at west line of Central avenue	1	6	"
King street east of railroad tracks.....	1	6	"
King street at blow off	1	6	"
King street on Shepard & Morse fire service..	1	6	"
Pine street on Malted Cereals Co. fire service.	1	6	"
Oak street at east line of St. Louis.....	1	4	"
Oak street at west line of St. Louis	1	4	"
St. Louis street at north line of Oak.....	1	4	"
Luck street at east line of St. Louis	1	4	"

Loomis street at east line of Prospect	1	4	inch
Prospect street at north line of North	1	4	"
Pine street at north line of College	1	4	"
Main street on B. H. S. fire service	1	4	"
<hr/>			
Total	37		
Total now in use	606		

REPAIRS.

The repairs for the year have been :

On cement pipe	1 break.
On cement pipe	2 leaks.
On cement pipe	2 pick holes.
On iron pipe	1 break.
On iron pipe	10 leaks.
On service pipes	11 leaks.
On broken hydrants	10

RESOLUTION RELATING TO REPLACING CEMENT
PIPE WITH IRON PIPE AND ADDING TWO
HYDRANTS IN LAKE STREET.

CITY OF BURLINGTON, In the year One Thousand Eight Hundred and Ninety-nine.

Resolved by the City Council of the City of Burlington as follows :

That the Water Commissioners be and they are hereby directed to replace the present cement pipe from a point near the office of Messrs. W. & D. G. Crane, thence northerly in Lake street, a distance of about 870 feet with six inch iron pipe, and attach to the same two fire hydrants, in place of the two defective hydrants lately removed : provided said W. & D. G. Crane will execute a good and sufficient bond to the City of Burlington, that they will repay to said city all expenses incurred by said city in carrying out said change in said piping and said hydrants, in the event that it is subsequently determined by the courts that the land in which said pipe is laid, is not a public street.

Resolved, That, the sum of eight hundred dollars be and it is hereby placed to the credit of the Water Department, to defray the entire expense of said work.

Resolution offered by Alderman Shea in Board meeting Nov. 6th, 1899, and then passed.

Resolution was approved by the Mayor Nov. 10th, 1899.

The Messrs. Crane filed a bond Nov. 8th, 1899.

In compliance with instructions of the City Council contained in the above resolution, 865 feet of six inch cast iron pipe were laid as designated.

The current appropriation of \$800.00 made for the purpose was not used. The expense of the work—

Pipe 13 1070 ¹⁰⁷⁰ / ₂₂₄₀ T at \$28.80...	\$448 51
Time on pay-roll.....	185 35
One hydrant.....	30 00
712 pounds special castings at .03.....	21 36
1-6 inch gate, yarn, coal oil, etc.....	14 69

\$699 91

is included in the current expenses of the Department for the year.

HIGH SERVICE.

The consumption on the high service has been about the same as last year, and the amount unaccounted for remains about the same, viz: 8 per cent.

METERS.

To prevent the negligence of meter takers resulting in unexpectedly large bills, such as a constant unnoticed waste, extending over the greater part of a quarter might cause, since June first, statements have been taken monthly, and the attention of the taker at once directed to any unusually large consumption thus discovered.

While there is no good reason the city should assume the cost of attending to the business of individual water consumers, frequent inspection often results in the deprivation of the complainant, in regard to a large meter bill, of ground on which to stand, and in a way serves to promote harmony and satisfaction.

In case of small consumers, not desiring the protection from unnoticed waste afforded by frequent inspection or objecting to the unnecessarily frequent intrusion of an agent of the Water Department, quarterly inspections only are made.

There are now in use 2,121 meters, an increase of 158 over last year.

Of the water pumped, 50 per cent has passed through meters yielding 77 per cent of the revenue.

Respectfully submitted,

F. H. CRANDALL, Supt.

Statement of Examinations of City Water made at the State Laboratory of the State Board of Health.

No.	Collected	Examined	Turbidity	Sediment	Color	ODOR		PARTS PER 100,000				Chlorine.	Hardness	Source	BACTERIA No. per c. c.
						Cold	Hot.	Total Solids	Loss on Ignition	Fixed Solids	Free	Album- enoid.			
3938	3-8-99	3-8-99	None	Very slight		Very faint	Very faint	8.1	2.6	5.4	.0070	.0140	1.08		48.
3939	3-8-99	3-8-99	"	"		"	"	6.8	1.6	5.2	.0026	.0138			250.
3940	3-8-99	3-8-99	"	"		"	"	6.6	2.1	4.6	.0024	.0128			75.
4441	5-3-99	5-3-99	"	None		"	"	6.52	1.92	4.6	.0032	.0140	1.1	Tap, State Laboratory	35.
4517	5-11-99	5-11-99	Very slight	Very slight		"	Increased	7.12	2.1	5.12	.0042	.0144	1.1	N. Reservoir	43.
4534	5-12-99	5-12-99	"	"		"	Very faint	6.72	2.36	4.32	.0018	.0122	.06	Intake.	638.
4535	5-13-99	5-13-99	None	None		"	"	7.48	2.36	5.12	.0030	.0144	1	Tap, house of J. H. L.	12.
4612	5-27-99	5-27-99	Slight	"		"	"	7.4	2.4	5.	.0024	.0132	1	Tap, State Lab.	11.
4689	6-2-99	6-2-99	Slight	"		"	"	7.18	2.4	5.53	.0030	.0122	1	"	11.
4738	6-10-99	6-10-99	None	"		"	"	7.1	2.1	5.1	.0024	.0122	.14	"	11.
5166	8-2-99	8-2-99	None	Slight	.2	"	"	9.4	4.1	5.4	.0014	.0154	.16	"	11.
5560	9-5-99	9-5-99	None	None	.1	None	"	7.16	2.36	4.8	.0014	.0134	.18	"	13.
5895	10-5-99	10-5-99	"	"	.2	"	"	7.2	2.4	4.8	.0014	.0140	2	"	200.
6177	11-2-99	11-2-99	"	"	.2	"	"	6.52	2.2	4.4	.0028	.0170	.18	Pump well	360.
6178	11-2-99	11-2-99	"	"	.2	"	"	6.2	2.2	4.2	.0028	.0162	.18	Tap, State Lab.	117.
6179	11-2-99	11-2-99	"	"	.1	"	"	7.12	2.1	5.12	.0028	.0110	.18	Tap, New Reservoir	75.
6180	11-2-99	11-2-99	"	"	.1	"	"	5.6	2.2	4.8	.0034	.0101	.14	Tap, High Reservoir	285.
6181	11-2-99	11-2-99	"	Very slight	.1	"	"	7.12	2.8	4.32	.0030	.0134	.12	Tap, Old Reservoir	105.
6189	11-3-99	11-3-99	"	"	.1	"	"	7.12	2.8	4.32	.0030	.0134	.18	"	344.
6190	11-3-99	11-3-99	"	"	.1	"	"	7.24	2.44	4.8	.0036	.0136	.16	Tap, New Reservoir	440.
6648	12-19-99	12-19-99	"	"	.1	Very faint	Very faint	6.6	2.2	4.2	.0036	.0160	.2	Tap, North Reservoir	400.
6649	12-19-99	12-19-99	"	"	.1	None	None	6.6	2.2	4.2	.0036	.0150	.16	Tap, South Reservoir	300.
6650	12-19-99	12-19-99	"	"	.1	Very faint	Very faint	6.4	2.2	4.4	.0036	.0164	.2	Tap, High Reservoir	325.
6659	12-20-99	12-20-99	Very slight	"	.1	"	"	6.4	2.2	4.2	.0036	.0168	.18	Pump well	600.
6660	12-20-99	12-20-99	"	None	.1	"	"	6.72	2.4	4.32	.0036	.0160	.2	"	395.
6663	12-20-99	12-20-99	"	Very slight	.1	"	"	6.8	2.8	4.	.0036	.0150	.18	Tap, Lafaountain St.	1128.
6664	12-20-99	12-20-99	"	None	.1	"	"	6.8	2.8	4.	.0036	.0140	.2	Tap, Rock Point	500.
Average.													.14		268.

1899.

SUMMARY OF STATISTICS

SUGGESTED BY

NEW ENGLAND WATER WORKS ASSOCIATION.

Burlington City Water Works.
 Burlington, Chittenden County, Vermont.
 Population by U. S. census, 1890, 14,590.
 Works constructed 1867-8.
 Owned by City.
 Source of supply, Lake Champlain.
 Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel $\left\{ \begin{array}{l} b \text{ Bituminous.} \\ d \text{ Reynoldsville.} \\ e \text{ \$2.67}\frac{1}{2}. \\ g \text{ Mill shavings} \end{array} \right\} 13 \text{ weeks.}$
3. Total pumpage for the year, 308,912,525 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet. Cost of pumping figured on pumping station expenses, \$6,131.39.
11. Per million gallons raised against dynamic head into reservoir, \$19.91.
12. Per million gallons raised one foot high (dynamic), \$0.06. Cost of pumping figured on total maintenance, \$36,936.67.

13. Per million gallons raised against dynamic head into reservoir, \$119.92.
14. Per million gallons raised one foot high (dynamic) \$0.379.

FINANCIAL.

Division I.

MAINTENANCE.

RECEIPTS.		EXPENDITURES.	
From Consumers :		AA. Management and repairs.	
A. Water rates, domestic.....	\$39,068 93	Repl. cement.....	\$7,275 22
B. Water rates, mfg.....	3,334 66	Current expenses.....	9,858 41
Net receipts for water.....	\$42,403 59	Pumping ".....	6,131 39
D. Miscellaneous.....	1,533 76	Meter ".....	3,591 65
E. Total.....	\$43,936 95		\$26,856 67
From public funds :		BB. Interest on bonds and notes.....	10,080 00
F. Hydrants.....	\$3,480 00	CC. Total maintenance.....	\$36,936 67
H. Street watering*.....	2,357 15	DD. Balance to Con.....	\$2,726 42
I. Public buildings and parks*.....	291 97	" " S. F.....	7,829,11
Watering troughs.....	250 00	" " C. Tr.....	2,823 87
	\$6,379 12	Total balance.....	\$13,379 40
K. Gross receipts from all sources.....	\$50,316 07	EE. Total.....	\$50,316 07

Division II.

From fixed rates.	{	L. Domestic	\$10,952 11
		M. Manufacturing	<u> </u>
		N.	\$10,952 11
From Meter rates.	{	O. Domestic	\$34,495 94
		P. Manufacturing	3,334 66
		Q.	<u>\$37,830 60</u>
		Total	<u>\$48,782 71</u>

*Paid at meter rates.

CONSTRUCTION.

RECEIPTS.	DISBURSEMENTS.
T. Trans. from Cur. App.....\$2,726 42	FF. Extension of mains.....\$2,191 04
V. Total.....\$2,726 42	GG. Extension of services.....535 38
	KK. Total.....\$2,726 42

W. Cost of work to date.....\$465,839 73

X. Bonded debt at date.....248,000 00

Y*. Value of sinking fund at this date.....196,359 82

Z*. Rate of interest, four per cent.

*Toward paying the entire bonded debt of the city \$779,000 00

CONSUMPTION.

1. Estimated total population at date, 18,600.
2. " " " on lines of pipe, 18,100.
3. " " " supplied, 17,900.
4. Total number of gallons consumed for year, 308,912,525.
5. Passed through domestic meters, 135,874,125 gallons, or 44 per cent.
6. Passed through manufacturing meters, 17,165,250 gallons, or 6 per cent.
7. Average daily consumption, 846,335 gallons.
8. Gallons per day to each inhabitant, 46.
9. Gallons per day to each consumer, 47.
10. Gallons per day to each tap, 257.

DISTRIBUTION.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Galvanized iron, cast iron and lead.
2. Size from 4 to 30 inches.	17. From one-half to six inches.
3. Extended, 2,596 feet.	18. 2,717 feet.
4. Discontinued, 4,360 feet.	19. 224 feet.
5. Total now in use, 38 miles.	20. 17 miles or 94,049 feet.
6. Cost of repairs per mile, \$10.19.	21. Service taps added, 90.
7. Leaks per mile, 0.36.	22. Number now in use, 3,292.
8. Small distribution pipe less than four-inch, total length, 14,380 ft.	23. Average length of services, 28 feet.
9. Hydrants added, 8.	24. Average cost of services, \$8.80.
10. Number now in use, 213.	25. Meters added, 158.
11. Stop-gates added, 33.	26. Number now in use, 2,121.
12. Number now in use, 606.	a. domestic.....2,082.
13. Small stop-gates less than four-inch, total 59.	b. manufacturing... 39.
14. Number of blow-off gates, 12.	27. Motors and elevators added, 0.
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.	28. Number now in use, 35.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons ; iron tank, high service, capacity 169,617 gallons.

THIRTY-FOURTH ANNUAL



OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.

AND OF THE

WATER COMMISSIONERS

THE TWELFTH.

DECEMBER 31, 1900.

THIRTY-FOURTH ANNUAL REPORT
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.
AND OF THE
WATER COMMISSIONERS
THE TWELFTH.

DECEMBER 31, 1900.

BOARD OF WATER COMMISSIONERS.

ALVARO ADSIT, Chairman. (Term expires 1901).

JAMES E. MEAGHER. (Term expires 1902).

J. E. LANOU. (Term expires 1903).

OFFICERS.

FRANK H. CRANDALL, C. E., Superintendent.

MISS F. P. EADY, REGISTRAR.

MISS K. M. McCAFFREY, Office Assistant.

JOEL W. THOMAS, Engineer at Pumping Station.

WILLIAM CASSIDY, Foreman.

OSCAR HEININGER, Chief Inspector.

TWELFTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington :

GENTLEMEN :—In compliance with the city ordinance, the Water Commissioners respectfully submit the following, their report for the year ending December 31, 1900.

The receipts from water rates for the year have been \$49,093.46, an increase of \$310.75 over the receipts of last year. This excess, following the recent reduction of rates, is largely due to the use by the village of Winooski of from ten to eighteen thousand cubic feet per day for the last three months of the year.

A temporary connection, between the fire service of the Burlington Flouring Company and the Winooski mains with a three inch meter in the cellar of the Flouring Mill was installed and maintained by the Winooski Aqueduct Company without expense to the City of Burlington. The temporary line crossing the bridge has not, as yet, been taken up, though it has been disconnected at both ends, and the meter removed. There is, at present, no connection between the Winooski Aqueduct Company and those of this city.

The unusually large amount of the unpaid bills for water, \$425.27, an excess of \$346.55 over the amount report-

ed a year ago, is due to our inability to collect bills to the amount of \$326.35 for metered water furnished to a department of the city.

The water supply is now off for non-payment in four places only, and there is no reason to expect that the city will be the loser by reason of the non-payment of any of the bills carried forward.

The indicated pumpage for the year, 312,896,525 gallons, is about 4,000,000 in excess of that of 1899. Taking into account the fact that of this amount about 11,000,000 were consumed in Winooski, it is apparent that our consumption for the year has been about 7,000,000 less than for 1899, or about 35,000,000 less than that of 1893.

The pumping machinery has recently been thoroughly overhauled and is in condition to render as efficient service as at any time since its purchase.

The stone post, mentioned in the recorded description of the Pumping Station premises, as marking the intersection of the north line of the right of way with the west line of Lake Street, has not, as yet, been set.

In response to a resolution of your Honorable Board, calling upon the Central Vermont Railroad Company to vacate Lake street, or arrange to set apart other land acceptable to the city in lieu thereof, a representative of that corporation recently visited this city, and was shown the location of Lake street and the water main in the North Lumber yard. The latter lies along under the railroad track from Cranes's office, northerly, for a distance of about two thousand feet.

The condition of the market, though tending to lower prices, has not been such as to encourage extensions, and it has again been deemed best to curtail pipe laying wherever

possible, without serious detriment to the service, and make correspondingly increased deposits to the sinking fund.

The receipts for 1899, the amount provided for disbursement in 1900, have proved sufficient to meet the current expenses of the department, interest included, pay a debt of \$2,200.00, authorized by your Honorable Board for Construction, and increase the sinking fund by \$12,296.58.

The bonded debt of the city incurred for this department is made up as follows :

4 per cent. bonds due in 1906.....	\$160,000 00
" " " " " " 1914.....	30,000 00
" " " " " " 1919	58,000 00
Total.....	\$248,000.00

Fifteen thousand of the issue due in 1906 are held by the sinking fund. There is no other outstanding indebtedness incurred for the water department.

Since the enactment of the amendment to the city charter requiring that "A sum not less than five per cent. of the amount of the gross receipts from all sources derived from the use of water for the year ending the 31st of December of the year previous, shall be placed to the credit of the sinking fund, to be applied in the reduction of the bonded and other indebtedness of the city incurred for the benefit of the water department," deposits have been made with the City Treasurer as follows :

To pay other than bonded debts incurred by authority of the City Council.

Dec. 31, 1899.	Construction account for the year,	\$2,726	42
Dec. 31, 1900.	" " " " "	2,200	00

To be applied in reduction of the bonded debt.

September 10, 1897,	5 per cent. required by charter	2,360	25
August 4, 1898,	" " " " "	2,259	16
August 10, 1899,	" " " " "	2,297	94
August 14, 1900,	" " " " "	2,439	13
November 9, 1899,	surplus funds.....	4,000	00
December 31, 1899,	" "	1,531	17
December 31, 1900,	" "	9,857	45

Total.....\$24,745 10

The resolution, establishing a discount on all bills for water paid before 10 P. M., of the 10th day of the month in which they become due, has now been in force for three collection periods. About eighty-five per cent. of the water takers save the discount, and the saving in office work is considerable.

While the regulations, in regard to the granting of the discount, have been generally satisfactory, there have been, as was to be expected, some instances of parties who felt, or claimed to feel, that during the first ten days of the water collection period, they were too busy to attend to the matter, and that, in their case, the discount should be permitted on the 11th or later. But few such cases have come to our notice, nearly all of the delinquent rate payers appreciating the fact that some rule is necessary, and that the five per cent. is but a small penalty for their thoughtlessness or neglect.

Your Water Commissioners appreciate the fact that they have no authority to make exceptions to the regulations provided for their guidance, and in the matter of discounts, have seen no cause to recommend that exceptions be made. Our

experience indicates that with continued fair and impartial observance of the regulations, in regard to discount, the general satisfaction with the same will increase, rather than diminish. The statement is occasionally made, "If every one, paying later than the 10th, loses his discount, I am willing to, but if there are any exceptions, I wish to be included in the list." It is hardly necessary to say that your instructions, in this matter, have been carefully followed.

The number of those to whom any considerable variation in the amount of the water bill immediately suggests inaccuracy of the meter, as also the number of those who fail to appreciate the peculiarity of the request that water wasted be furnished at a less rate than the same quantities legitimately used, is becoming noticeably less.

Owing to the better acquaintance of the general public with the water meter, and in part, no doubt, to the frequent inspections now in vogue, there have been, during the year, but two written applications for rebate of meter bills. In neither case were we able to recommend to your Honorable Board that the request be granted, and in neither case was it granted.

Biological and chemical examinations have been made as usual, at the laboratory of the State Board of Health. For tabulated statement of these examinations, as also for other details of the season's work and expenditures, reference is made to the accompanying report of the Superintendent.

Respectfully submitted,

A. ADSIT,

J. E. MEAGHER,

J. E. LANOU.

} Water
Commissioners.

THIRTY FOURTH ANNUAL REPORT.
OF THE
SUPERINTENDENT OF WATER WORKS.

*To the Honorable Board of Water Commissioners of the City
of Burlington, Vt.:*

GENTLEMEN :—The following is a statement of
the receipts and disbursements of the Burlington City Water
Works for the year ending December 31, 1900.

RECEIPTS.

From L. C. Grant, City Treasurer :

Amt. of appropriations for current ex- penses.....	\$46,343 58
“ of appropriations for sinking fund	2,439 13

Total amount of appropriations	\$48,782 71
Sales of material, permits, &c	1,914 69
Transfer from current to construction account.	2,200 00
	<hr/> \$52,897 40

DISBURSEMENTS.

Construction :

Cast iron pipe	\$ 600 00
Labor on mains	1,060 04
Material for services.	\$238 81
Labor on services	301 15 539 96
	<hr/>
Total construction	\$2,200 00

<i>Current :</i>		MAINTENANCE.
Pay-rolls.....	\$2,619	80
Salary of Superintendent	1,200	00
Care and repair of reservoir premises.	518	39
Stable expenses	468	70
Material for management and repairs.	483	81
City of Burlington, other departments	444	90
Salary of Registrar	400	00
Hydrant inspection and repairs ...	334	13
Salary of Water Commissioners.....	300	00
Pipe and fittings.....	241	68
*Dr. Bradley's extension.....	225	00
Hydrants	180	00
Repair of tools.....	162	26
Coal for office, store-room and tank ..	154	50
Printing, advertising and postage.....	150	95
Office expenses	109	64
*Queen City Cotton Company's extension.....	100	00
New England Telephone and Telegraph Co.....	79	30
Care and repair of private telephone line	62	77
Gas for office and store-rooms.....	27	16
		<hr/> \$8,262 99
<i>Replacing of cement pipe with cast iron :</i>		
Labor	\$2,930	58
Pipe.....	2,504	37
Lead and yarn	613	37
Gates.....	266	25
		<hr/> \$6,314 57

* Work done at the expense of the owner of the premises.

Interest :

Interest on debt \$9,920 00

PUMPING.*Low Service Station :*

Fuel	\$4,434 02
Pay-rolls	2,062 68
Repairs to machinery	504 32
Repairs to buildings and grounds	360 96
Supplies	191 60
Boiler insurance	80 00
Fire brick	74 95
Gas	55 78
	<hr/>
	\$7,764 31

High Service Station :

Station pay-roll	\$183 57
Fuel and lights	33 91
Repairs to building	21 59
Steam pump, pay-roll ..	\$34 86
" fuel	36 94
" repairs ..	10 00 81 80
Motor, pay-rolls	134 92
" repairs	49 02 183 94
	<hr/>
	504 81
	<hr/>
	\$8,269 12

Meters :

Pay-rolls	\$1,703 46
Meters	1,430 52
Freight and repair bills	300 16
	<hr/>
	\$3,434 14

Total maintenance \$36,200 82

TRANSFERS.

To sinking fund	\$12,296 58
To construction account.....	2,200 00
Total transfers	<u>\$14,496 58</u>
Total disbursements	52,897 40

RECAPITULATION.**RECEIPTS.**

From L. C. Grant, City Treasurer.....	\$52,897 40
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DISBURSEMENTS.

Transfer to construction....	\$ 2,200 00
Transfer to sinking fund....	12,296 58
Total transfers	<u>\$14,496 58</u>
Construction.....	2,200 00
Current.....	\$8,262 99
Replacing.....	6,314 57
Pumping.....	8,269 12
Meters.....	3,434 14
	<u>\$26,280 82</u>
Interest.....	9,920 00
Total maintenance.....	<u>\$36,200 82</u>
Total disbursements.....	\$52,397 40

WATER TAX COLLECTIONS.**RECEIPTS.**

Schedule rates.....	\$ 9,689 17
Meter rates.....	39,404 29
Total receipts.....	<u>\$49,093 46</u>

DISBURSEMENTS.

L. C. Grant, City Treasurer.....\$49,093 46

UNPAID WATER RATES.

Schedule rates, eight in number.....\$ 39 85

Meter rates, fourteen in number..... 385 42

Total unpaid water rates forward to 1901.....\$425 27

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1900, of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

We also find that the provision of the water ordinance, relative to penalty for failure to pay promptly, has been fairly and impartially enforced.

GEO. W. BECKWITH,
JOHN C. FARRAR,
THOMAS FAILEY, } Auditors.

Statement of assessments and current expenditures for year ending December 31, 1900.

The paid assessments of this statement are the receipts for the year, less whatever portion of the same was assessed previous to January 1, 1900. The unpaid are the unpaid of January 1, 1901, less whatever portion of same are of more than one year's standing.

ASSESSMENTS.		DISBURSEMENTS.	
PAID.		Interest.....	\$ 9,920 00
Meter rates.....	\$39,364 09	Replacing cement pipe.....	6,314 57
Schedule rate....	9,665 98	Current.....	\$8,262 99
	\$49,030 07	Pumping.....	8,269 12
Mat. and labor	1,861 30	Meters.	3,434 14
	\$50,891 37	Total maintenance.....	\$36,200 82
UNPAID.		Excess of assess- ments	
Meter rates.....	\$375 86	To sinking fund	\$12,296 58
Schedule rates.....	39 85	" Construction...	2,200 00
	\$415 71	" City Treas.....	193 97
Material and labor	117 58	" City Treas.....	533 29
	533 29	Total excess.....	\$15,223 84
	\$51,424 66		\$51,424 66

WATER PUMPED.

1900.	Gallons.
January	20,572,950
February	19,008,175
March	20,939,475
April	22,393,650
May	25,728,125
June	29,607,500
July	36,670,825
August	26,862,500
September	30,284,625
October	25,464,950
November	30,182,925
December	25,180,825
Total.....	312,896,525
Total, 1899	308,912,525
Increase in 1900.....	3,984,000
Daily average in 1900.....	857,250
Daily average in 1899.....	846,335

SERVICES.

There have been added 61 services of the following sizes:

Fifty-two.....	1/2 inch.
One.....	3/4 "
Three.....	1 "
Five.....	2 "

Of the above, three, one for Wells & Richardson Company on Pine street, one for the Malted Cereals Company on Pine street, and one for H. L. Ward on Willard street, corner of Main street, replace old services.

HYDRANTS.

There have been no new hydrants ordered during the year. During the progress of the season's work, the following changes of location have been made:

Union Street, N. W. cor. Maple to N. E. cor.

Mansfield Avenue, S. W. cor. Loomis to N. W. cor.

Bank Street, S. E. cor. Battery to N. E. cor.

Pearl Street, N. W. cor. Clarke, branch extended 2 1/2 feet northerly to permit relocation of curb.

A capped hydrant base was set on Brookes Avenue, N. W. cor. North Willard Street.

Total number of public hydrants 177

Total number of private hydrants 36

Total..... 213

SUPPLY PIPE.

There has been no supply pipe either added or discontinued during the past year.

Total length of supply pipe now in use..... 14,380 feet.

MAINS.

New mains have been laid as follows :

	WITH 10 INCH CAST IRON PIPE.	Feet.
Willard street from College street, southerly..		481

	WITH 8 INCH CAST IRON PIPE.	
Willard street from Main street main, northerly to 10 inch.....		6

	WITH 6 INCH CAST IRON PIPE.	
Brookes avenue from Willard street, easterly to dead end		866
Central avenue from Harrison, northerly to dead end		320
Bradley Place, so-called, easterly from Union.		312
Wright avenue, so-called, westerly from dead end		75
Drew street, northerly from North.....		6

	WITH 4 INCH CAST IRON PIPE.	
Drew street from 6 inch in North street, north- erly to dead end.....		323
East avenue, southerly from dead end		1044
Clarke street from Pearl street, northerly to dead end.....		156
		<hr/> 3,589

Cement pipe in the following streets has been replaced :

	WITH 16 INCH CAST IRON PIPE.	
College street from Williams to Willard.....		679

WITH 10 INCH CAST IRON PIPE.

Pearl street from Clarke street to Winooski avenue.....	357
College street, westerly from 16 inch	15

WITH 8 INCH CAST IRON PIPE.

Union street from Main to Maple.....	806
Winooski avenue to Pearl street.....	47
Pine street at Bank.....	70

WITH 6 INCH CAST IRON PIPE.

Union street, southerly from Main street main.....	10
Bank street from St. Paul street to Battery.....	1,117
Battery street from College to Bank	381

WITH 4 INCH CAST IRON PIPE.

Battery street, northerly from College street main.....	6
Total replaced.....	3,488

LENGTH OF PIPE NOW IN USE.

Cement.....	35,421 feet.	7 miles
Iron	167,041 "	31 "
Total.....	202,462 "	38 "

GATES.

The following gates have been discontinued :

College street at Williams.....	1	10 inch
Pearl street at Winooski avenue.....	2	6 "
Winooski avenue at Pearl street.....	1	6 "
Union street at Main.....	1	4 "
Maple street at Union	1	4 "
Bank street at Pine.....	2	4 "

Bank street at Battery	I	4	inch
Battery street at Bank.....	I	4	"
Pine street at Bank.....	I	4	"
<hr/>			
Total discontinued.....	II		

Gates have been set in the following locations :

College street at west line of Williams.....	I	16	inch
College street at west line of Willard.....	I	16	"
College street at east line of Willard	I	16	"
Willard street at south line of College.	I	10	"
Willard street at north line of Main.....	I	10	"
Pearl street at east line of Winooski avenue..	I	10	"
Pearl street at west line of Winooski avenue.	I	10	"
Union street at south line of Main.....	I	8	"
Union street at north line of Maple.....	I	8	"
Winooski avenue at north line of Pearl.....	I	8	"
Pine street at north line of Bank.....	I	8	"
Pine street at south line of Bank.....	I	8	"
Bank street at west line of Pine.....	I	6	"
Bank street at east line of Pine	I	6	"
Bank street at east line of Battery.....	I	6	"
Battery street at north line of Bank	I	6	"
Battery street at south line of Bank	I	6	"
Brookes avenue at east line of Willard.....	I	6	"
Central avenue at north line of Harrison....	I	6	"
Battery street at north line of College.....	I	4	"
Drew street at north line of North	I	4	"
Clarke street at north line of Pearl.....	I	4	"
Maple street at Union.....	I	4	"
<hr/>			
Total	23		
Total now in use	618		

REPAIRS.

The repairs for the year have been :

On cement pipe	1 break.
On cement pipe	4 leaks.
On cement pipe.....	1 pick hole.
On iron pipe	2 wooden plugs.
On iron pipe	7 joint leaks.
On service pipes.....	14 leaks.
On broken hydrants.....	14

On the receipt of requests from Dr. Bradley and the Queen City Cotton Company, that water mains be laid on their property at their expense, with the understanding that when the land, in which mains are requested, shall be accepted and water mains ordered, they shall be reimbursed, the following resolution was passed.

"CITY OF BURLINGTON, In the Year One Thousand Nine Hundred :

Resolved by the City Council of the City of Burlington as follows :

That the Water Commissioners be and they hereby are authorized, on receipt of the estimated cost of the work, to lay pipe for Dr. Bradley and the Queen City Cotton Company, in accordance with their propositions received through the Water Commissioners.

Offered by Alderman Shea, and adopted by the Board of Aldermen November 3, 1900. Approved November 5, 1900. "

In compliance with the instructions of the City Council contained in the above resolution, on the receipt from the Queen City Cotton Company of \$100.00, and from Dr. Bradley of \$225.00, to be returned to them, as above provided, extensions were made as requested.

HIGH SERVICE.

The consumption on the high service, as indicated by the pumping record of that station, was about thirteen million gallons, or about 4 per cent. of that of the low service. Of this amount about $77\frac{1}{4}$ per cent. was measured to consumers through meters. Four per cent. was estimated to have been used where meters stopped and where it was inexpedient to apply meters, five per cent. was the estimated loss in the motor, and about $13\frac{3}{4}$ per cent. remains unaccounted for.

About 82 per cent. of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 18 per cent. by the auxiliary steam plant.

METERS.

There are now in use 2,311 meters, an increase of 190 over last year.

Of the water pumped, 53 per cent. has passed through meters yielding 80 per cent. of the revenue.

Respectfully submitted,

F. H. CRANDALL, Supt.

Statement of Examination of City Water made at the State Laboratory of the State Board of Health.

No.	Collected Ex'm'd	Turbidity	Sediment	Color	ODOR		PARTS PER 100,000				Chlorine	Hardness	Source	BACTERIA	
					Cold	Hot	RESIDUE			AMMONIA				No. per C. C.	No. per C. C.
							Total Solids	Loss on Ignition	Fixed Solids							Free Albu- minoid
7895	3-28-'00	None	None	.1	Very faint	Very faint	6.16	1.76	4.4	.0030	.0134	.2	Intake	495.	495.
7896	3-28-'00	"	"	.1	"	"	6.2	1.76	4.44	.0038	.0134	.2	Lake	450.	450.
7897	3-28-'00	"	"	.1	"	"	6.72	2.4	4.32	.0026	.0128	.22	"	500.	500.
7898	3-28-'00	"	"	.1	"	"	7.36	2.	4.36	.0022	.0118	.2	"	450.	450.
7899	3-28-'00	"	"	.1	"	"	6.4	2.	4.4	.0040	.0144	.22	"	1200.	1200.
7900	3-28-'00	"	"	.1	"	"	6.68	2.	4.68	.0020	.0136	.2	"	1010.	1010.
7901	3-28-'00	"	"	.1	"	"	6.04	1.72	4.32	.0032	.0120	.24	"	1080.	1080.
7902	3-28-'00	"	"	.1	"	"	6.04	1.56	4.48	.0020	.0101	.2	"	1000.	1000.
7903	3-28-'00	"	"	.1	"	"	5.96	1.6	4.36	.0050	.0114	.2	"	950.	950.
7904	3-28-'00	"	"	.1	"	"	6	1.6	4.39	.0042	.0122	.2	"	1090.	1090.
7905	3-28-'00	Slight	Cloudy	.1	"	"	6.12	1.64	4.48	.0044	.0122	.26	"	3000.	3000.
7906	3-28-'00	Distinct	Consid'ble	.1	"	"	5.96	1.44	4.52	.0036	.0114	.36	"	3750.	3750.
7907	3-28-'00	"	None	.1	"	"	6	1.4	4.6	.0048	.0114	.28	"	950.	950.
7908	3-28-'00	"	"	.1	"	"	6.08	1.6	4.48	.0042	.0122	.24	"	950.	950.
7909	3-28-'00	"	"	.1	"	"	5.6	1.4	4.2	.0036	.0134	.24	"	950.	950.
8970	7-2-'00	None	"	.00	"	"	6.72	2	4.72	.0016	.0132	.24	"	150.	150.
8971	7-2-'00	"	"	.00	"	"	6.8	2.2	4.6	.0028	.0170	.24	"	800.	800.
8985	7-3-'00	"	"	.00	"	"	7.48	2.4	5.08	.0050	.0138	.26	"	450.	450.
8986	7-3-'00	"	"	.00	"	"	7.6	2.4	5.2	.0044	.0128	.21	"	600.	600.
9010	7-5-'00	"	"	.00	"	"	"	"	"	.0000	.0114	.24	"	500.	500.
9011	7-5-'00	"	"	.00	"	"	"	"	"	.0014	.0124	.26	"	750.	750.
9015	7-6-'00	"	"	.00	"	"	7.6	2.6	5	.0074	.0150	.24	"	660.	660.
9016	7-6-'00	"	"	.00	"	"	7.88	2.6	5.28	.0053	.0152	.2	"	700.	700.
9043	7-7-'00	"	"	.20	Faint	Faint	"	"	"	.0053	.0180	.2	"	500.	500.
9044	7-7-'00	"	"	.00	"	"	"	"	"	"	"	"	"	"	"
9051	7-9-'00	"	"	.00	"	"	"	"	"	"	"	"	"	"	"

Statement of Examination of City Water made at the State Laboratory of the State Board of Health.—Continued.

No.	Collected Ex'min'd	Turbidity	Sediment	Color	ODOR		PARTS PER 100,000					Hardness	Source	No. per c. c.	No. Colon per c. c.	BACTERIA
					Cold	Hot	RESIDUE			AMMONIA						
							Total Solids	Loss on Ignition	Pfied Solids	Free	Albu-minoid						Chlorine
3032	7- 9-'00	None	None	.00	Faint	Faint	6.64	1.4	5.24	.0020	.0152	24	Reservoir	1200.		
3033	7- 9-'00	"	"	.00	"	"	9.12	6.7	.0044	.0132	3	Tap, Laboratory	250.			
3034	7-11-'00	"	"	.00	None	None	7.8	1.8	.0036	.0138	4	High service tap	190.			
3035	7-11-'00	"	"	.00	"	"	6.4	1.4	.0038	.0140	3	New res. after clean'g	130.			
3036	7-12-'00	"	"	.00	"	"	6.68	1.3	.0042	.0148	2	Reservoir	1100.			
3037	7-12-'00	"	"	.00	"	"	6.64	1.4	.0028	.0148	2	Reservoir	1320.			
3038	7-12-'00	"	"	.00	"	"	6.64	1.4	5.44	.0143	16	Low ser. (res) imp. w. k.	700.			
3039	7-13-'00	"	"	.00	"	"	7.08	2.2	5.08	.0042	.0128	2	Hi ser. tap p. p. 1 st. st	390.		
3040	7-13-'00	"	"	.00	"	"	7.6	2.2	.0036	.0128	2	Hi ser. tap p. p. 1 st. st	700.			
3041	10-15-'00	"	"	.00	"	"	6.8	1.2	4.6	.0042	.0160	2	Tap, Laboratory	300.		
3042	10-15-'00	"	"	.00	"	"	8.	2.4	5.6	.0046	.0168	2	North reservoir	100.		
3043	10-20-'00	"	"	.00	"	"	8.	2.4	5.6	.0046	.0168	2	High service tank tap	300.		
3044	10-20-'00	Slight	"	Cloudy	Very faint	Very faint	7.8	1.8	.0036	.0138	4	North reservoir tank tap	300.			
3045	10-20-'00	None	"	Cloudy	None	None	6.4	1.4	.0038	.0140	3	South reservoir	350.			
3046	10-20-'00	"	"	.00	"	"	6.68	1.3	.0042	.0148	2	South reservoir	350.			
3047	10-30-'00	"	"	.00	"	"	6.64	1.4	.0028	.0148	2	South reservoir tap	50.			
3048	10-30-'00	"	"	.00	"	"	6.64	1.4	5.44	.0143	16	South reservoir tap	150.			
3049	10-30-'00	"	"	.00	"	"	7.08	2.2	5.08	.0042	.0160	2	Hi ser. tap, Sum't St.	675.		
3050	10-30-'00	"	"	.00	"	"	7.6	2.2	.0036	.0128	2	Hi. serv. tank B. W. W.	600.			
3051	10-31-'00	"	"	.00	"	"	6.8	1.2	4.6	.0042	.0160	2	Hi. serv. tank B. W. W.	300.		
3052	10-31-'00	"	"	.00	"	"	8.	2.4	5.6	.0046	.0168	2	Hi. ser. tap, Sum't St.	300.		
3053	10-31-'00	"	"	.00	"	"	8.	2.4	5.6	.0046	.0168	2	South reservoir	100.		
3054	10-31-'00	"	"	.00	"	"	6.8	1.4	5.4	.0046	.0152	34	North reservoir	100.		
3055	10-31-'00	"	"	.00	"	"	6.8	1.4	5.4	.0046	.0154	24	North reservoir	100.		
3056	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0046	.0088	26	High service tap	35		
3057	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0046	.0088	26	High service tap	75		
3058	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2	So. res. tap. 4 ft. water	150.		
3059	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2	in res. going into serv.			
3060	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3061	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3062	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3063	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3064	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3065	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3066	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3067	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3068	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3069	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3070	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3071	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3072	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3073	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3074	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3075	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3076	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3077	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3078	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3079	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3080	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3081	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3082	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3083	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3084	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3085	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3086	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3087	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3088	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3089	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3090	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3091	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3092	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3093	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3094	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3095	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3096	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3097	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3098	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3099	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3100	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3101	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3102	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3103	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3104	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3105	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3106	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3107	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3108	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3109	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3110	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3111	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3112	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3113	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3114	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3115	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3116	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3117	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3118	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3119	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3120	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3121	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3122	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3123	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3124	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3125	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3126	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3127	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3128	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3129	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3130	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3131	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3132	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3133	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3134	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3135	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3136	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042	.0176	2				
3137	11- 1-'00	"	"	.00	"	"	6.8	1.4	5.4	.0042</						

• Dregs, at time of cleaning, not counted in making averages.

1900

SUMMARY OF STATISTICS

SUGGESTED BY

NEW ENGLAND WATER WORKS ASSOCIATION.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

Population by U. S. census, 1900, 18,640.

Works constructed 1867-8.

Owned by City.

Source of supply, Lake Champlain.

Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel $\left\{ \begin{array}{l} b \text{ Bituminous.} \\ d \text{ Reynoldsville.} \\ e \text{ \$3.70.} \\ g \text{ Mill shavings 1 week.} \end{array} \right\} 51 \text{ weeks.}$
6. Total pumpage for the year, 312,896,525 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet. Cost of Pumping, figured on Pumping Station Expenses, viz., \$8,269.12.
11. Per million gallons raised against dynamic head into reservoir, \$26.17.
12. Per million gallons raised one foot high (dynamic), \$0.08. Cost of Pumping, figured on total maintenance, viz., \$36,200.82.
13. Per million gallons raised against dynamic head into reservoir, \$114.55.
14. Per million gallons raised one foot high (dynamic) \$0.366.

FINANCIAL.**Division I.****MAINTENANCE.**

RECEIPTS.		EXPENDITURES.	
From Consumers :		AA. Management and repairs.	
A. Water rates, domestic	\$38,239 01	Repl. cement.....	\$6,314 57
B. Water rates, manufacturing	3,953 21	Current.....	8,262 99
C. Net receipts for water	\$42,192 22	Pumping	8,269 12
D. Miscellaneous.....	1,914 69	Meters.....	3,434 14
E. Total.....	\$44,106 91		\$26,280 82
From public funds :		BB. Interest on bonds.....	9,920 00
F. Hydrants.....	\$3,540 00	CC. Total maintenance	\$36,200 82
G*. Fountains.....	230 45	DD. Balance to Con. .	\$ 2,200 00
H*. Street watering.....	2,056 34	" " S. F. .	12,296 58
I*. Public buildings	586 23	" " C. Tr. .	310 75
Watering troughs.....	243 75	Total balance.....	\$14,807 33
Other public use.....	244 47	EE. Total.....	\$51,008 15
	\$ 6,901 24		
K. Gross receipts from all sources.....	\$51,008 15		

Division II.

From fixed rates.	L. Domestic....	\$ 9,689 17
	M. Manufacturing	
	N.	\$9,689 17
From Meter rates.	O. Domestic....	\$35,451 08
	P. Manufacturing	3,953 21
	Q.	\$39,404 29
Total		\$49,093 46

CONSTRUCTION.

RECEIPTS.		DISBURSEMENTS.	
T. Trans. from Cur. App.....	\$2,200 00	FF. Extension of mains	\$1,660 04
V. Total.....	\$2,200 00	GG. Extension of services.....	539 96
		KK. Total.....	\$2,200 09

* Paid at meter rates.

W.	Cost of work to date.....	\$468,039 73
X.	Bonded debt to date	248,000 00
Y†.	Value of sinking fund at this date.....	64,076 40
Z†.	Rate of interest, three and one-half and four per cent.	

CONSUMPTION.

1. Estimated total population at date, 18,800.
2. " " " on lines of pipe, 18,300.
3. " " " supplied, 18,100.
4. Total number of gallons consumed for year, 312,-
896,525.
5. Passed through domestic meters, 140,045,612 gal-
lons, or 45 per cent.
6. Passed through manufacturing meters, 27,797,250
gallons, or 8 per cent.
7. Average daily consumption, 857,250 gallons.
8. Gallons per day to each inhabitant, 46.
9. Gallons per day to each consumer, 47.
10. Gallons per day to each tap, 256.

DISTRIBUTION.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Galvanized iron, cast iron and lead.
2. Size from 4 to 30 inches.	17. From one-half to six inches.
3. Extended, 7,077 feet.	18. 1,891 feet.
4. Discontinued, 3,488 feet.	19. 120 feet.
5. Total now in use, 38 miles.	20. 18 miles or 95,820 feet.
6. Cost of repairs per mile, \$4.61.	21. Service taps added, 61.
7. Leaks per mile, 0.36.	22. Number now in use, 3,350.
8. Small distribution pipe less than four inch, total length 14,380 ft.	23. Average length of services, 31 feet.
9. Hydrants added, 0.	24. Average cost of services, \$9.01.
10. Number now in use, 213.	25. Meters added, 190.
11. Stop-gates added, 23.	26. Meters now in use, a. domestic.....2,271 b. manuf'g..... 40 Total.....2,311.
12. Number now in use, 618.	27. Motors and elevators added, 0.
13. Small stop-gates less than four- inch, total 59.	28. Number now in use, 35.
14. Number of blow-off gates, 12.	
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.	

† Toward paying the entire bonded debt of the city, \$625,000.00.

Per

Thirty-fifth Annual Report

OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.,

AND OF THE

Water Commissioners

THE THIRTEENTH.

DECEMBER 31, 1901.

Thirty-fifth Annual Report
OF THE
WATER DEPARTMENT


OF THE

~~CITY OF BURLINGTON~~ BURLINGTON, VT.,

COMPLIMENTS OF

FRANK H. GRANDALL.

SUPT. sioners

 Please exchange.

THE THIRTEENTH.

DECEMBER 31, 1901.

BURLINGTON
FREE PRESS ASSOCIATION
PRINTERS, BINDERS AND STATIONERS
1901

BOARD OF WATER COMMISSIONERS.

J. W. GOODELL, Chairman, (Term expires, 1904).

J. E. LANOU, (Term expires, 1903).

JAMES E. MEAGHER, (Term expires, 1902).

OFFICERS.

FRANK H. CRANDALL, C. E., Superintendent.

Miss F. P. EADY, Registrar.

Miss K. M. McCaffrey, Office Assistant.

JOEL W. THOMAS, Engineer at Pumping Station.

WILLIAM CASSIDY, Foreman.

OSCAR HEININGER, Chief Inspector.

THIRTEENTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

GENTLEMEN:—As enjoined by the city ordinances, the Water Commissioners submit their report for the year ending December 31, 1901.

The receipts from water rates for the year have been \$47,831.58, a decrease of \$1,262.93 from the receipts of the previous year. The decrease is the result of a reduction of rates that has been in effect during the whole of this year, and the five per cent. discount amounted to about \$2,400.00 on the collections made.

We are pleased to report a very small amount of uncollected bills, there being only \$59.26 now due for water, and we feel the present ordinances, relative to collections, are giving very general satisfaction to consumers, and well protect the interests of the city. The water is now shut off in only four places for non-payment.

The pumping station and reservoirs are in good condition, and some improvements have been made during the year. The pumps have proved fully equal to all requirements, and the cost for running them has not been excessively large, but there is no doubt that new pumps, with the modern improvements, would supply the same amount of water at a less cost, so that on the ground of economy, and to insure against any possible contingency, there should be new pumps installed within a very few years, and the present pumps held in reserve, as an emergency

supply, although, as yet, there has never been a lack of water to supply every demand.

All constructive work ordered by your Honorable Board, has been completed and is now in use. The laying of the new main in the Lower Road was tedious and expensive, as much rock was encountered that required drilling and blasting, but it was accomplished at a cost within the estimate and the appropriation for that purpose.

The conditions, relative to the stone post to mark the boundary of right of way, and the occupation of Lake street by the Central Vermont Railroad, remain the same as reported last year.

During the year we have had a careful inspection of the intake pipe made by Mr. Falcon, the gentleman who laid it when it was put down, and the Superintendent who, also, made a personal examination of some parts of the work many feet below the surface of the lake. The whole line was found in excellent condition, and tests have proved there were no appreciable leaks. The quality of our water continues to be of the very best.

The amount provided for disbursement during the year, being the sum received for water in 1900, has enabled the department to pay the current expense for the year, interest on the water bonds, the sum of \$6,421.50 for construction, as ordered by the City Council, and to deposit in the sinking fund, for liquidating the water works indebtedness, the sum of \$7,665.64.

There has been paid into the sinking fund of the water department, since the charter was amended in 1896, a total of \$32,410.74, on which interest, in a savings bank, would exceed \$1,595.98, and make present amount in excess of \$34,006.72.

Your Water Commissioners have a confident hope that when the \$160,000.00 of water bonds, due in 1906, are payable, the sum in the sinking fund will reduce the issue of the new

bonds by an amount that will add strength to the now high credit of the city, and show that Burlington creates a sinking fund to liquidate maturing liabilities.

For details of the work of the department and other information, we refer you to the accompanying report of the Superintendent, which is very complete.

Respectfully submitted,

J. W. GOODELL,	}	Water Commissioners.
J. E. MEAGHER,		
J. E. LANOU,		

THIRTY-FIFTH ANNUAL REPORT OF THE Superintendent of Water Works.

*To the Honorable Board of Water Commissioners of the City
of Burlington, Vt.:*

GENTLEMEN:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1901.

RECEIPTS.

From L. C. Grant, City Treasurer:

Amount of appropriation for current expenses	\$46,638 79
Amount of appropriation for sinking fund	2,454 67

Total amount of appropriations	\$49,093 46
Receipts for material and labor	1,354 21
Transfer from current to construction account...	6,421 50
	\$56,869 17

DISBURSEMENTS.

Construction:

Labor on mains	\$2,570 12
Cast iron pipe	1,934 49
Tools and supplies for rock cut	461 00
Lead, yarn, etc.	313 25
Damage	13 88

WATER DEPARTMENT.

7

Wrought iron pipe	\$346 73	
Labor on services	302 03	
Boxes	280 00	
Stops	200 00	
		<hr/>
		1,128 76
		<hr/>
Total construction	\$6,421 50	

MAINTENANCE.

Current:

Pay-rolls	\$2,921 11	
Salary of Superintendent	1,200 00	
Intake inspection and repairs.....	660 20	
Stable expenses	580 05	
Salary of Registrar	480 00	
City of Burlington, other departments,	470 08	
Material for management and repairs,	463 87	
Care and repair of reservoir premises,	402 51	
Service boxes	400 00	
Hydrant inspection and repairs	393 26	
By order of City Council.....	350 01	
Salary of Water Commissioners....	300 00	
Care and repair of tank.....	127 97	
Printing, advertising and postage....	120 55	
Pipe and fittings	119 63	
Office expenses	82 71	
Care and repair of watering troughs,	73 60	
Telephone rent	70 00	
Repair of tools	56 72	
Prof. W. H. Freedman, electrical		
survey	40 00	
Taking samples for State Board of		
Health	20 75	
Damages	20 49	
		<hr/>
		\$9,347 51

Replacing of cement pipe with cast iron:

Labor	\$2,305 24	
Pipe	2,004 95	
Stops and gate valves	946 41	
Lead, yarn, etc.	424 44	
		\$5,681 04

Interest:

Interest on debt	\$9,920 00
------------------------	------------

PUMPING.*Low Service Station:*

Fuel	\$4,028 72	
Pay-rolls	2,038 45	
Repairs to buildings and grounds....	735 13	
Repairs to machinery	497 60	
Well house	316 60	
Supplies	212 85	
Rolling grates	200 45	
Gas	62 08	
		\$8,091 88

High Service Station:

Station pay-roll	\$171 45	
Repairs to building	28 89	
Fuel and lights	25 56	
Steam pump, fuel,..	\$40 70	
Steam pump, pay- roll	20 25	
Steam pump, repairs,	6 39	
		67 34
Motor, pay-rolls ..	\$116 25	
Motor, repairs	64 52	
		180 77
		474 01
		\$8,565 89

<i>Meters:</i>	
Pay-rolls	\$1,378 36
Meters	1,166 66
Freight and repair bills.....	301 07
	<u>\$2,846 09</u>
Total maintenance	\$36,360 53

TRANSFERS.

To sinking fund, 5% required.....	\$2,454 67
To sinking fund, surplus funds.....	5,210 97
To construction account	6,421 50
	<u>\$14,087 14</u>
Total transfers	\$14,087 14
Total disbursements	\$56,869 17

RECAPITULATION

RECEIPTS.

From L. C. Grant, City Treasurer.....	\$56,869 17
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DISBURSEMENTS.

Transfer to construction.	\$6,421 50
Transfer to sinking fund, 5% required	2,454 67
Transfer to sinking fund, surplus funds	5,210 97
Total transfers	\$14,087 14
Construction	6,421 50
Current	\$9,347 51
Replacing .. .	5,681 04
Pumping .. .	8,565 89
Meters	2,846 09
	<u>\$26,440 53</u>

Interest	9,920 00
Total maintenance	\$36,360 53
Total disbursements	\$56,869 17

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates	\$ 9,001 93
Meter rates	38,829 60
Total receipts	\$47,831 53

DISBURSEMENTS.

L. C. Grant, City Treasurer.....	\$47,831 53
----------------------------------	-------------

UNPAID WATER RATES.

Schedule rates, three in number.....	\$ 7 87
Meter rates, eight in number.....	51 39
Total unpaid water rates forward to 1902....	\$59 26

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1901, of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

We also find that the provisions of the water ordinance, relative to collection of water rates, discount, penalty, etc., have been fairly and impartially administered.

JOHN C. FARRAR,	} Auditors.
THOMAS FAILEY,	
GEO. W. BECKWITH,	

Statement of assessments and current expenditures for the year ending December 31, 1901.

The paid assessments of this statement are the receipts for the year, less whatever portion of the same was assessed previous to January 1, 1901. The unpaid are the unpaid of January 1, 1902, less whatever portion of same are of more than one year's standing.

ASSESSMENTS.		DISBURSEMENTS.	
PAID.			
Meter rates....	\$38,459 67	Interest	\$ 9,920 00
Sched. rates..	8,962 08	Replacing cement pipe ..	5,681 04
		Current	\$9,347 51
	\$47,421 75	Pumping	8,565 89
Mat. and labor, 1,235 28	\$48,657 03	Meters	2,846 09 20,759 49
UNPAID.		Total maintenance	\$36,360 53
Meter rates....	\$35 90	Excess of assessments	
Sched. rates....	7 87	over disbursements for	
	\$43 77	the year 1901	\$12,422 61
Mat. and labor	82 34 \$ 126 11		
	\$48,783 14		\$48,783 14

1901.	WATER PUMPED.	Gallons.
January		23,485,950
February		24,764,300
March		26,099,075
April		21,591,900
May		24,481,025
June		30,589,400
July		33,020,050
August		28,168,050
September		24,535,350
October		26,960,025
November		20,492,925
December		20,497,725
Total		304,685,775

Total, 1900	312,896,525
Decrease in 1901	8,210,750
Daily average in 1901	834,755
Daily average in 1900	857,250

SERVICES.

There have been added 72 services of the following sizes:

Sixty	$\frac{1}{2}$ inch.
Five	$\frac{3}{4}$ inch.
One	1 inch.
Five	2 inch.
One	6 inch.

Of the above, a $\frac{1}{2}$ inch service for Mr. Fred Johonnott on South Union street was put in prior to road improvement, and has not, as yet, been taken up. A $\frac{1}{2}$ inch service for Dr. Lund, No. 52 Monroe street, and a $\frac{3}{4}$ inch service for Dr. Wilder, No. 253 Pearl street, replace old services.

HYDRANTS.

There have been two new public hydrants set during the past year on the Lower Road to Winooski. During the progress of the season's work, the following changes were made.

Two hydrants in the North Lumber Yard were discontinued. The hydrant on the west side of Elmwood avenue at Spring street was replaced by a hydrant on the north side of Spring street in triangular grass plot.

The four inch post hydrant on Loomis street at Union street was replaced by a larger hydrant with six inch branch and base. The four inch post hydrant on the north-west corner of Union and Adams streets was replaced by a larger hydrant with six inch branch and base, located on the south-west corner of Adams and Union streets. A four-way hydrant was set in the yard at the Low Service Station.

Total number of public hydrants.....	177
Total number of private hydrants	37
Total	214

SUPPLY PIPE.

Two hundred twenty-four feet of one inch supply pipe in School street have been discontinued during the past season, leaving the total length of supply pipe now in use, 14,156 feet.

MAINS.

New mains have been laid as follows:

	Feet.
WITH 10 INCH CAST IRON PIPE.	
Lower Road to Winooski, from 8 inch westerly.....	848
WITH 8 INCH CAST IRON PIPE.	
Lower Road to Winooski, from 6 inch westerly....	1,048
WITH 6 INCH CAST IRON PIPE.	
Lower Road to Winooski, from Colchester avenue southerly	1,051
Orchard Terrace from Buell street, southerly.....	147
North street from Mansfield avenue, westerly.....	427
WITH 4 INCH CAST IRON PIPE.	
Green street from Loomis street, southerly.....	175
School street from Loomis street, northerly.....	224
Total length of new mains.....	3,920
Cement pipe in the following streets has been replaced:	
	Feet.
WITH 8 INCH CAST IRON PIPE.	
South Union street from Maple to Adams streets.....	610

 WITH 6 INCH CAST IRON PIPE.

Loomis street from Union street westerly to iron pipe..	669
North Union street at Loomis street.....	108
North Union street from North street to Winooski Ave.	457
Spring street from Walnut street to North Bend street,	472
Elmwood avenue from Spring street to Cedar street...	600
South Union street from Adams street southerly to iron pipe	455
Maple street at South Union street.....	108
Total replaced	3,479

LENGTH OF PIPE NOW IN USE.

Cement	31,942 feet.	6 miles.
Cast iron	174,440 feet.	33 miles.
Total	206,382 feet.	39 miles.

GATES.

The following gates have been discontinued:

Loomis street at Union	1	4	inch.
Maple street at Union	1	4	"
Union street opposite No. 319.....	1	4	"
Union street at Adams.....	1	4	"
North street at Willard	1	4	"
Total discontinued	5		

Gates have been set in the following locations:

Lower Road to Winooski	2	6	inch.
Orchard Terrace at south line of Buell.....	1	6	"
Maple street at east line of South Union.....	1	6	"
Maple street at west line of South Union.....	1	6	"
Union street at south line of Adams.....	1	6	"
Spring street at west line of Walnut.....	1	6	"
Spring street at east line of North Bend.....	1	6	"
Elmwood avenue at Spring	1	6	"

Elmwood avenue at north line of Cedar.....	1	6	"
Union street at north line of Adams.....	1	8	"
Union street at south line of Maple.....	1	8	"
Green street at south line of Loomis.....	1	4	"
School street at north line of Loomis.....	1	4	"
Union street at north line of Loomis.....	1	6	"
Union street at south line of Loomis.....	1	6	"
Loomis street at east line of Union.....	1	6	"
Loomis street at east line of School.....	1	6	"
Robinson-Edwards Lumber Co., fire service, Pine street	1	6	"
Burlington Water Works, fire service, Lake front,	1	6	"
<hr/>			
Total	20		
Total now in use	633		

REPAIRS.

The repairs for the year have been:

On cement pipe.....	1 break.
On cement pipe.....	1 leak.
On iron pipe.....	1 joint leak.
On service pipes	8 leaks.
On gates	1
On hydrants	12

In compliance with the instruction conveyed by the following resolution, a six inch fire service has been laid from Pine street and connected with the four inch service from Champlain street, as requested by the Robinson-Edwards Lumber Company, at an expense of three hundred and ninety-nine dollars and forty-seven cents, which has been paid by the said company.

"Resolution relating to laying of water main on the premises of the Robinson-Edwards Lumber Company.

City of Burlington, in the year One Thousand Nine Hundred.

Resolved by the City Council of the City of Burlington, as follows:

THAT the Water Commissioners be, and they are hereby instructed, to lay a water main across the land of Robinson & Edwards, if so requested in writing, upon the receipt of a check for the estimated cost of the work, with the understanding that when the land upon which this main is laid, is accepted by the city as a street and the work of laying water main ordered by the City Council in said street, the main will then be purchased by Commissioners of the Burlington City Water Works at price paid for it. Should the expense of said work be less than the estimate, said Robinson & Edwards shall be repaid the difference between the actual cost and the sum advanced by them; should the expense of said work be greater than the estimated cost, said Robinson & Edwards shall pay to the city the excess of actual cost above the estimated cost."

Approved November 30th, 1900.

ELECTROLYSIS.

An examination, made by Professor W. H. Freedman of the Electrical Engineering Department of the U. V. M., indicates electrical conditions not materially different from those obtaining in 1896, when Mr. H. A. Storrs, then Professor of Electrical Engineering at the University, made a similar investigation.

A comparison of the figures, obtained by Prof. Freedman in this city, with those contained in reports on electrolysis in other cities, serves to indicate that the electrical deterioration of water pipes in this city is not taking place with any considerable degree of rapidity.

SINKING FUND.

Deposits to this fund have been made with the City Treasurer as follows:

Dec. 31, 1899, Construction account for the year..	\$2,726	42
Dec. 31, 1900, Construction account for the year..	2,200	00
Dec. 31, 1901, Construction account for the year..	6,421	50

To be applied in reduction of the bonded debt.

September 10, 1897, 5 per cent. required by charter..	\$2,360	25
August 4, 1898, 5 per cent. required by charter...	2,259	16
August 10, 1899, 5 per cent. required by charter...	2,297	94
August 14, 1900, 5 per cent. required by charter...	2,439	13
August 8, 1901, 5 per cent. required by charter...	2,454	67
November 9, 1899, surplus funds.....	4,000	00
December 31, 1899, surplus funds.....	1,531	17
December 31, 1900, surplus funds.....	9,857	45
December 31, 1901, surplus funds.....	5,210	97

Total\$32,410 74

HIGH SERVICE.

The consumption on the high service, as indicated by the pumping record of that station, was about thirteen million gallons, or about 4% of that of the low service. Of this amount about 82% was measured to consumers through meters; 1% was estimated to have been used where meters stopped and where it was inexpedient to apply meters, 5% was the estimated loss in the motor, and about 12% remains unaccounted for.

About 81% of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 19% by the auxiliary steam plant.

METERS.

There are now in use 2,401 meters, an increase of 90 over last year.

Of the water pumped, 54% has passed through meters yielding 81% of the revenue.

Respectfully submitted,

F. H. CRANDALL, Supt.

Statement of Examination of City Water made at the Laboratory of the State
Board of Health.

Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	ODOR.		RESIDUE.			ANAL.		Hardness.
						Cold.	Hot.	Total Solids.	Loss on Ignition.	Fixed Solids.	Free.	Albuminoid.	Chlorine.
11397	2-27-01	2-28-01	None.	Very slight.	.1	None.	None.	6.76	1.40	5.36	.0034	.0134	.11
11621	3-18-01	3-18-01	"	"	.0	Faint.	Faint.	7.04	1.58	5.46	.0024	.0142	.05
11623	3-18-01	3-18-01	"	"	.0	"	"	8.72	1.56	5.16	.0024	.0142	.05
11624	3-18-01	3-18-01	"	"	.0	"	"	8.72	1.56	7.07	.0028	.0142	.05
11655	3-18-01	3-18-01	"	"	.0	None.	None.	6.44	1.72	4.72	.0028	.0142	.05
11656	3-18-01	3-18-01	"	"	.0	"	"	6.44	1.72	4.72	.0028	.0142	.05
11657	3-18-01	3-18-01	"	"	.0	Very faint.	Very faint.	6.03	1.74	4.29	.0020	.0138	.09
11654	3-20-01	3-20-01	"	"	.0	Faint.	Faint.	6.31	1.40	4.92	.0020	.0138	.08
11801	4-1-01	4-1-01	Very slight.	"	.0	Distinct.	Distinct.	6.00	1.90	4.10	.0016	.0153	.05
11802	4-1-01	4-1-01	"	"	.0	"	"	6.00	2.10	4.90	.0028	.0138	.05
11803	4-1-01	4-1-01	None.	"	.0	"	"	6.50	1.90	6.60	.0022	.0138	.05
11804	4-1-01	4-1-01	"	"	.0	"	"	7.90	1.60	6.00	.0028	.0138	.05
12082	4-27-01	4-27-01	Very slight.	"	.0	"	"	7.12	1.68	5.44	.0012	.0198	.11
12328	5-17-01	5-17-01	Slight.	"	.0	Faint.	Faint.	7.60	1.40	6.20	.0040	.0198	.10
13231	7-26-01	7-29-01	Slight.	Slight.	.0	None.	None.	7.00	1.25	5.75	.0038	.0168	.12
13232	7-26-01	7-29-01	Distinct.	Slight.	.0	"	"	7.15	1.75	5.40	.0018	.0168	.14
13629	8-22-01	8-22-01	"	"	.0	Faint.	Faint.	6.40	1.30	5.10	.0012	.0140	.14
13974	9-20-01	9-20-01	"	"	.0	Distinct.	Distinct.	6.75	1.60	5.15	.0014	.0134	.11
14371	10-21-01	10-21-01	"	"	.0	"	"	6.40	1.70	4.70	.0012	.0168	.10
14856	11-29-01	11-29-01	Very slight.	"	.08	Very faint.	Very faint.	6.50	1.85	4.65	.0008	.0098	.11
15045	12-13-01	12-13-01	Slight.	"	.03	"	"	6.60	1.80	4.80	.0018	.0086	.13
15087	12-17-01	12-17-01	Decided.	Considerable.	Cloudy.	Distinct.	Distinct.	7.35	2.15	5.20	.0012	.0112	.11
15109	12-18-01	12-18-01	Distinct.	Slight.	.10	Very faint.	Very faint.	7.05	2.10	4.95	.0018	.0116	.13
15123	12-19-01	12-19-01	Slight.	"	.10	Faint.	Faint.	6.90	2.60	4.30	.0012	.0096	.14

C

**Statement of Examination of City Water made at the Laboratory of the State
Board of Health.—Continued.**

Source.	BACTERIA.		Nitrogen as Nitrates.	Nitrogen as Nitrites.	Microscopically.	Remarks.
	No. per c.	No. Colon per c.				
Tap at Laboratory	132				A few cil. prot. a little amor., veg. deb.	B. and C. water is a good quality
Tap at 476 St. Paul St.	700		.0140 .0000		Num. cil. prot. a few diatoms.	" " " "
67 Elmwood Ave.	600		.0120 .0000		A few inorganic-cr. cil. prot. diatoms.	" " " "
72 Chase St.	1000	Pres. few.	.0130 .0000		" " " "	C. is unob. B. shows pres. of colon bac.
109 Summit St.	6-8	Few.	.0130 .0000		" " " "	" " " "
Reservoir tap.	1000	Pres. few.	.0130 .0000		" " " "	" " " "
Pump. Sta. tap.	900	Pres. few.	.0130 .0000		" " " "	" " " "
Tap at Laboratory	700		.0170 .0000		Negative	B. and C. water is a good quality
Tap at low ser. Res.	900		.0150 .0000		Ciliated protozoa diatoms	" " " "
H. S. Tap at Summit St.	900		.0150 .0000		" " "	" " " "
Tap at 72 Chase	500		.0160 .0000		" " "	" " " "
Tap at low ser. sta.	400		.0170 .0000		Few veg. fibres, cil. prot. diatoms	" " " "
Tap at Laboratory	300		.0190 .0000		Ciliated protozoa, amor. matter diatoms	" " " "
Tap at Laboratory	100		.0190 .0000		Diatoms, protozoa, amor. matter	" " " "
North Reservoir	300	No.	.0160 .0000		Ciliated protozoa, few dia. amor. matter.	" " " "
South Reservoir	400		.0070 .0000		" " " "	" " " "
Tap at Laboratory	600		.0080 .0000		Many asterionella and synedra, few prot.	" " " "
Tap at Laboratory	600		.0100 .0000		Small amt. of prot., quite a large amt. dia.	" " " "
Tap at Laboratory	600		.0150 .0000		" " " veg. matter; also a few pro-	" " " "
Tap at Laboratory	800	Yes.	.0170 .0000		tozoa and diatoms.	" " " "
Tap at Laboratory	1200		.0170 .0000		Some asterionella, few synedra, puichella,	C. is unob. B. shows pres. of the bac-
Tap at Laboratory	6400	Pres. few.	.0200 .0000		slight amt. of a - or. matter.	cillus coli communis (sew. bacteria)
Tap at Laboratory	3400	Pres.	.0200 .0000		Small amt. of veg. and amor. matter.	B. and C. water is a good quality
Tap at Laboratory	2400		.0120 .0000		Small amt. of asterionella, large amt. of	C. is unob. B. shows pres. of the bac-
Tap at Laboratory	2400		.0120 .0000		amor. matter.	coli. communis—sen. bacteria
Tap at Laboratory	2400		.0120 .0000		Large amt. of amor. matter, few asteri-	C. is unob. B. shows pres. of the bac-
Tap at Laboratory	2400		.0120 .0000		onella, and synedra	coli. communis—sew. bacteria
Tap at Laboratory	2400		.0120 .0000		Small amt. of asterionella, large amt. of	C. is unob. biologically the no. of bacte-
Tap at Laboratory	2400		.0120 .0000		amor. deposit	ria is high.

1901

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.
Burlington, Chittenden County, Vermont.
Population by U. S. census, 1900, 18,640.
Works constructed 1867-8.
Owned by City.
Source of supply, Lake Champlain.
Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel.

{	<i>b</i> Bituminous.
{	<i>d</i> Clearfield.
{	<i>e</i> \$4.05.
6. Total pumpage for the year, 304,685,775 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet. (*Cost of pumping, figured on Pumping Station expenses, viz., \$8,565.89.*)
11. Per million gallons raised against dynamic head into reservoir, \$28.17.
12. Per million gallons raised one foot high (dynamic), \$0.089. (*Cost of pumping, figured on total maintenance, viz., \$36,360.53.*)
13. Per million gallons raised against dynamic head into reservoir, \$119.60.
14. Per million gallons raised one foot high (dynamic), \$0.378.

FINANCIAL.

Division I.

MAINTENANCE.

RECEIPTS.	EXPENDITURES.
<p>From Consumers:</p> <p>A. Water rates, domestic.....\$37,898.68</p> <p>B. Water rates, manufacturing 3,168.65</p> <hr/> <p>C. Net receipts for water.....\$41,067.33</p> <p>D. Miscellaneous 1,354.21</p> <hr/> <p>E. Total .....\$42,421.54</p> <p>From public funds:</p> <p>F. Hydrants .....\$3,540.00</p> <p>G.* Fountains and pks. 708.74</p> <p>H.* Street watering.... 1,732.88</p> <p>I.* Public buildings ... 433.69</p> <p>Watering troughs.. 237.50</p> <p>Other public use.... 111.49</p> <hr/> <p>\$ 6,764.20</p> <p>K. Gross receipts from all sources .....\$49,185.74</p>	<p>AA. Management and repairs.</p> <p>Repl. cement .....\$5,681.04</p> <p>Current 9,347.51</p> <p>Pumping 8,565.89</p> <p>Meters 2,846.09</p> <hr/> <p>\$26,440.53</p> <p>BB. Interest on bonds..... 9,920.00</p> <hr/> <p>CC. Total maintenance .....\$36,360.53</p> <p>DD. Bal. to Con.....\$6,421.50</p> <p>Bal. to S. F..... 6,403.71</p> <hr/> <p>Total balance .....\$12,825.21</p> <hr/> <p>EE. Total ... .....\$49,185.74</p>

*Paid at meter rates.

Division II.

From fixed rates.

L. Domestic.... \$ 9,001 93

M. Manufacturing

N. \$ 9,001 93

From meter rates.

O. Domestic . . . \$35,660 95

P. Manufacturing 3,168.65

Q. \$38,829 60

Total \$47,831 53

CONSTRUCTION.

RECEIPTS.	DISBURSEMENTS.
T. Trans. from Cur. App.....\$6,421.50	FF. Extension of mains.....\$5,292.74
	GG. Extension of services..... 1,128.76
V. Total .....\$6,421.50	KK. Total .....\$6,421.50
W. Cost of works to date .....\$474,461 23	
X. Bonded debt at date 248,000 00	
Y. Value of sinking fund at this date, about... 34,000 00	
Z. Rate of interest, four per cent.	

CONSUMPTION.

1. Estimated total population at date, 19,000.
2. Estimated total population on lines of pipe, 18,500.
3. Estimated total population supplied, 18,400.
4. Total number of gallons consumed for year, 304,685,-
775.
5. Passed through domestic meters, 148,191,420 gallons,
or 49 per cent.
6. Passed through manufacturing meters, 16,389,750 gal-
lons, or 5 per cent.
7. Average daily consumption, 835,249 gallons.
8. Gallons per day to each inhabitant, 44.
9. Gallons per day to each consumer, 40.
10. Gallons per day to each tap, 244.

DISTRIBUTION.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Galvanized iron, cast iron and lead.
2. Size from 4 to 30 inches.	17. From one-half to six inches.
3. Extended, 7,399 feet.	18. 2,042 feet
4. Discontinued, 3,479 feet.	19. 79 feet.
5. Total now in use, 39 miles.	20. 18.5 miles or 97,862 feet.
6. Cost of repairs per mile, \$6.86.	21. Service taps added, 70.
7. Leaks per mile, .3.	22. Number now in use, 3,420.
8. Small distribution pipes less than four inch, total length, 14,156 feet.	23. Average length of services, 28 feet.
9. Hydrants added, 1.	24. Average cost of services, \$8.00.
10. Number now in use, 214.	25. Meters added, 90.
11. Stop-gates added, 15.	26. Meters now in use,
12. Number now in use, 633.	a. domestic .....2,359
13. Small stop-gates less than four-inch, total 59.	b. manufacturing 42
14. Number of blow-off gates, 12.	Total .. ....2,401
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.	27. Motors and elevators added, 2.
	28. Number now in use, 35.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons; iron tank, high service, capacity 169,617 gallons.

BOSTON SOC
OF
CIVIL ENGRS

Thirty-sixth Annual Report
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.,
AND OF THE
Water Commissioners
THE FOURTEENTH.

DECEMBER 31, 1902.

BURLINGTON
FREE PRESS ASSOCIATION
PRINTERS, BINDERS AND STATIONERS
1903

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1903

BOARD OF WATER COMMISSIONERS.

- J. W. GOODELL, Chairman. (Term expires 1904).
J. J. FLYNN. (Term expires 1905).
J. E. LANOU. (Term expires 1903).

OFFICERS.

- FRANK H. CRANDALL, C. E., Superintendent.
MISS F. P. EADY, Registrar.
MISS K. M. MCCAFFREY, Office Assistant.
JOEL W. THOMAS, Engineer at Pumping Station.
WILLIAM CASSIDY, Foreman.
OSCAR HEININGER, Chief Inspector.

FOURTEENTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

Gentlemen:—In accordance with the provisions of the City Ordinance, the Board of Water Commissioners submit their report for the year ending December 31, 1902.

The receipts during the year, from service rates, amounted to \$42,817.47, notwithstanding the reduction in rates which were in effect during the last half of the year, and that no water was furnished for Winooski.

The amount of unpaid bills is only \$69.40, or only about 16-100 of one per cent of the sum collected, and this we expect will all be paid. This very small sum is evident proof of the wisdom shown by the adoption of the present ordinances relating to the payment of bills rendered by this department.

Water is now shut off in only two places for non-payment, and both of them were among the number reported one year ago.

The pumping station and reservoirs have been maintained in their usual good condition, and some improvements made during the year. The pumps have continued to furnish the city an abundant supply of water, and it has been of excellent quality.

All new work, ordered by the City Council, has been completed, and is now in use. There has been a large amount of work done in the line of current expense, much of which was made necessary by the grading of streets, thus leaving the mains in danger of freezing, although quite an amount of cement pipe has been replaced with iron, and some mains have been relaid with pipe of larger size.

The sum of \$47,831.53, provided for disbursement during the year, being the amount received for water in 1901, has enabled the department to pay all current expenses for the year, interest on all water

bonds, and to deposit in the sinking fund, for the payment of the liabilities of the city on account of the water works, the sum of \$9,286.07. The total amount paid into this sinking fund by this department, since the Amendment to the City Charter in 1896, is now \$41,696.81, which, with interest, should be worth \$44,275.00, or over, in liquidation of the water works indebtedness.

We would respectfully refer you to the report of the Superintendent, herewith submitted, for details and other information relative to the work of the department.

We are pleased to acknowledge the unvarying courtesy accorded to this Board by your Honorable Body during the year.

Respectfully submitted,

J. W. GOODELL,	}	Water Commissioners.
J. E. LANOU,		
JOHN J. FLYNN,		

THIRTY-SIXTH ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS.

To the Honorable Board of Water Commissioners of the City of Burlington, Vt.:

Gentlemen:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1902.

RECEIPTS.

From L. C. Grant, City Treasurer:

Amount of appropriation for current expenses... \$45,439 95

Amount of appropriations for sinking fund..... 2,391 58

Total amount of appropriations \$47,831 53

Receipts for material and labor 3,440 06

Transfer from current to construction account 1,174 17

Total receipts \$52,445 76

DISBURSEMENTS.

Construction:

Labor on mains \$397 80

Cast iron pipe 500 00

Labor on services 276 37

Total construction \$1,174 17

MAINTENANCE.

Current:

Pay-rolls \$ 3,154 68

Salary of Superintendent 1,200 00

Wrought iron pipe, fittings, etc 606 83

Stable expenses 597 05

Material for management and repairs	549 92	
Salary of Registrar	480 00	
City of Burlington, other departments	412 20	
Private telephone line	386 26	
Care and repair of reservoir premises	359 11	
Salary of Water Commissioners	300 00	
Hydrant inspection and repairs	292 59	
Returned to L. P. Wood	283 97	
High service tank cleaning and repairs	283 33	
Repair of tools	199 40	
Gate and meter wells	194 02	
Printing, advertising and postage	166 03	
Fire hose	100 71	
Office expenses	80 59	
Telephone rent	78 76	
Gas for office and shop	35 22	
		<hr/> 9,760 67

Lowering, relaying and replacing cast iron mains:

Pipe	\$2,325 86	
Labor	3,305 34	
Gates	938 40	
		<hr/> \$6,569 60

Replacing of cement pipe with cast iron:

Pipe	\$1,000 00	
Labor	1,198 41	
Gates	114 00	
		<hr/> \$2,312 41
		<hr/> \$8,882 01

Interest:

Interest on debt	\$9,920 00
------------------------	------------

PUMPING.*Low Service Station:*

Fuel	\$4,916 16	
Pay-rolls	2,370 38	
Repairs to buildings and grounds	321 15	
Supplies and tools	259 55	
Repairs to machinery	233 29	
Gas	79 32	
		<hr/> \$8,179 85

WATER DEPARTMENT.

7

High Service Station:

Station pay-roll	\$118 20
Fuel and light	34 50
Repairs to building	19 47
Recording dials	10 35

Steam Pump:

Fuel	\$58 57
Repairs	19 53
Pay-roll	18 90
	<hr/>
	\$97 00

Motor:

Pay-rolls	\$100 58
Repairs	99 60
	<hr/>
	\$200 18
	<hr/>
	\$479 70
	<hr/>
	\$8,659 55

Meters:

Pay-rolls	\$1,993 10
Meters	1,455 35
Freight and repair bills	140 67
	<hr/>
	\$3,589 12

Total maintenance	\$40,811 35
-------------------------	-------------

TRANSFERS.

To sinking fund, 5% required	\$2,391 58
To sinking fund, surplus funds	6,894 49
To construction account	1,174 17

Total transfers	\$10,460 24
-----------------------	-------------

Total disbursements	\$52,445 76
---------------------------	-------------

RECAPITULATION.

RECEIPTS.

From L. C. Grant, City Treasurer	\$52,445 76
--	-------------

DISBURSEMENTS.

Maintenance:

Current	\$9,760 67
Replacing	8,882 01

CITY OF BURLINGTON.

Pumping	8,659 55	
Meters	3,589 12	
		<hr/>
	\$30,891 35	
Interest	9,920 00	
Total maintenance	\$40,811 35	
Transfers	10,460 24	
Construction	1,174 17	
		<hr/>
Total disbursements	\$52,445 76	

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates	\$ 8,246 09
Meter rates	34,571 38
	<hr/>
Total receipts	\$42,817 47

DISBURSEMENTS.

L. C. Grant, City Treasurer	\$42,817 47
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UNPAID WATER RATES.

Meter rates, five in number	\$69 40
	<hr/>
Total unpaid water rates forward to 1903	\$69 40

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1902, of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

We also find that the provision of the water ordinance, relative to collection of water rates, discount, penalty, etc., have been fairly and impartially administered.

THOMAS FAILEY,	}	Auditors.
W. H. ROBERTS,		

Statement of assessments and current expenditures for year ending December 31, 1902.

The paid assessments of this statement are the receipts for the year, less whatever portion of the same was assessed previous to Janu-

WATER DEPARTMENT.

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ary 1, 1902. The unpaid are the unpaid of January 1, 1903, less whatever portion of the same are of more than one year's standing.

ASSESSMENTS.		DISBURSEMENTS.	
	PAID.	Interest	\$ 9,920 00
Meter rates....	\$34,530 81	Replacing	8,882 01
Sched. rates ..	8,239 79	Current	\$9,760 67
		Pumping	8,659 55
	\$42,770 60	Meters	8,589 12 22,009 34
Mat. and labor,	3,257 72 \$46,028 32	Total maintenance	\$40,811 35
		Excess of assessments	
	UNPAID.	over disbursements for	
Meter rates ..	\$58 58	the year 1902	\$5,275 55
	58 58		
	\$46,086 90		\$46,086 90

WATER PUMPED.

1902.	Gallons.
January	23,165,625
February	19,289,100
March	20,736,650
April	22,553,175
May	26,994,250
June	22,007,775
July	34,909,900
August	28,040,050
September	25,315,300
October	25,356,875
November.....	23,791,075
December	21,226,700
Total, 1901	304,685,775
Total, 1902	293,386,475
Decrease in 1902	11,299,300
Daily average in 1902	803,798
Daily average in 1901	834,775

SERVICES.

There have been added 47 services of the following sizes:

Thirty-four	½ inch.
Seven	¾ inch.

Three	1	inch.
Two	4	inch.
One	6	inch.

Of the above, a $\frac{1}{2}$ inch service for Mr. Patrick Ryan, No. 84 Archibald Street, and a $\frac{1}{2}$ inch service for Mrs. Josephine Muir on Elmwood Avenue, were put in prior to road improvement, and have not, as yet, been taken up. A $\frac{3}{4}$ inch service for Mr. R. J. Perkins, No. 272 Pearl Street, a $\frac{3}{4}$ inch service for Mr. John Wilson, No. 85 Mansfield Avenue, and a $\frac{3}{4}$ inch service for Adams School on South Union Street, replace old services.

HYDRANTS.

There has been one new public hydrant set during the past year at the north east corner of Brookes avenue and Willard street. During the progress of the season's work, the following changes were made.

One hydrant has been discontinued, that on Colchester avenue opposite the Ira Allen school.

The hydrant, located on the north east corner of Willard and Pearl streets, supplied from the Pearl street main by a four inch branch, was removed to the north west corner, and supplied from the Willard street main by a six inch branch.

The location of the hydrant near No. 316 Colchester avenue, at the request of the Street Department, and adjacent property owners, was slightly changed.

The following hydrants, with their branches, were lowered so as to secure a six foot cover on the branches without effecting any change in the location of the hydrants:

Battery street at Smith's lane.

Union street at Pearl street.

North Willard street at North street.

Loomis street at North Willard street.

The two-way post hydrants on Williams street at College and Main streets have been replaced by two-way post hydrants with steamer nozzle.

Total number of public hydrants	177
Total number of private hydrants	37

Total 214

SUPPLY PIPE.

During the progress of road improvement, thirty-nine feet of one and one-half inch pipe were laid from the main on the west side, under the stone roadway, to the east side of Colchester avenue at No. 454, making the total length of supply pipe now in use.....14,195 feet.

MAINS.

New Mains have been laid as follows:

With 6 inch Cast Iron Pipe.

Greene street from Pearl street, northerly	234 feet.
North Willard street from Pomeroy street, southerly	227 feet.

With 4 inch Cast Iron Pipe.

Oak street from St. Louis street, easterly	265 feet.
--	-----------

Total length of new mains	726 feet.
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Iron pipe has been relaid, lowered or replaced in the following streets:

	Feet.
Pearl street from Winooski avenue, easterly; 6 inch replaced with 10 inch	1,375
Colchester avenue from No. 316, easterly; 6 inch replaced with 10 inch	399
Colchester avenue from No. 316, westerly; 10 inch lowered.....	330
Colchester avenue from University place, easterly; 8 inch lowered	196
Colchester avenue from Barrett street, southerly; 6 inch lowered.	443
Barrett street from Colchester avenue, easterly; 6 inch lowered..	60
Union street from Pearl street, southerly; 4 inch replaced with 6 inch	65
University place from Pearl street, southerly, 8 inch lowered...	282
Oak street from Interval avenue, westerly; 4 inch lowered.....	135
Lafayette place from Pearl street, northerly; 4 inch lowered....	20
Orchard Terrace from Pearl street, southerly; 6 inch lowered ..	36
Mansfield avenue; 4 inch lowered	605
Battery street at Battery place; 10 inch lowered	134
Battery place at Battery street; 10 inch lowered	105
Willard street from Pearl street, southerly; 10 inch lowered....	38
Pomeroy street from Hyde street, easterly; 6 inch lowered	23
North Willard street from North street, northerly; 6 inch lowered	51

North Willard street from Pearl street, northerly; 4 inch replaced with 6 inch	26
Loomis street from North Willard street, easterly; 6 inch lowered	60
Willard street from Pearl street, northerly; 6 inch lowered....	40
Total	4,423

Cement pipe in the following streets has been replaced:

With 6 inch Cast Iron Pipe.

	Feet.
Elmwood avenue from Cedar street, southerly	348
Cedar street from Elmwood avenue, westerly	35
North Bend street from Spring street, westerly	131
Spring street from North Bend street, easterly	32
Smith's lane from Battery to Champlain streets	380
Pomeroy street from Hyde street, easterly	352
Archibald street from Interval avenue to Winooski avenue.....	860
Bright street from Archibald street, northerly	34
Union street from Pearl street, northerly	72

Total replaced 2,244

LENGTH OF PIPE NOW IN USE.

Cement	29,698 feet.	About 6 miles.
Cast iron	177,410 feet.	About 33 miles.

Total 207,108 feet. About 39 miles.

GATES.

The following gates have been discontinued:

Pearl street at Union	1	6 inch.
Union street at Pearl	2	4 "
Spring street at North Bend	1	4 "
Elmwood avenue at Cedar	1	4 "

Total discontinued 5

Gates have been set in the following locations:

Pearl street at west line of Union	1	10 inch.
Pearl street at east line of Union	1	10 "
Pearl street at west line of Greene	1	10 "
Pearl street at west line of Willard	1	10 "
Pine street at Whiting's	2	8 "

North Bend street at north line of Spring	1	6 inch.
Union street at north line of Pearl	1	6 "
Union street at south line of Pearl	1	6 "
Greene street at north line of Pearl	1	6 "
Pearl street at east line of Willard	1	6 "
Willard street at south line of Pomeroy	1	6 "
Willard street at north line of Pomeroy	1	6 "
Pomeroy street at west line of Willard	1	6 "
Pomeroy street at east line of Willard	1	6 "
Wood street at east line of Union	1	6 "
Archibald street at west line of Bright	1	6 "
Bright street at north line of Archibald	1	6 "
St. Paul street at Hinds'	1	6 "
Pine street on Whiting's fire service	1	6 "
Oak street at west line of St. Mary's	1	4 "
Oak street at east line of St. Mary's	1	4 "
College street on Woodbury's fire service	1	4 "
St. Paul street on Hinds' fire service	1	4 "

Total 24

Total now in use 652

REPAIRS.

The repairs for the year have been:

On cement pipe.....	2 breaks.
On cement pipe.....	1 leak.
On iron pipe.....	8 joint leaks.
On iron pipe.....	3 leaks.
On service pipe	16 leaks.

ELECTROLYSIS.

The work of the Department in mains in the vicinity of the Power Station of the Street Railway Company, has brought to light no indication of any material change of electrical conditions.

The replacing of the service for No. 429 Colchester avenue, which took place during the month of December, was apparently due to this cause.

A six inch cast iron main was, during the season, laid from Union street, easterly opposite No. 381, a distance of six hundred and thirty-seven feet, for and at the expense of Mr. L. P. Wood.

The understanding with Mr. Wood, in regard to the extension, is that should his proposed street be accepted, and the laying of a water main therein ordered by the City Council, the Water Department will take off his hands the pipe laid at the price paid to the Department for the same, viz: Seven hundred and sixteen dollars and three cents.

SINKING FUND.

Deposits to this fund have been made with the City Treasurer as follows:

Dec. 31, 1899, Construction account for the year	\$2,726 42
Dec. 31, 1900, Construction account for the year	2,200 00
Dec. 31, 1901, Construction account for the year	6,421 50
Dec. 31, 1902, Construction account for the year	1,174 17
To be applied in reduction of the bonded debt.	
September 10, 1897, 5 per cent required by charter	\$2,360 25
August 4, 1898, 5 per cent required by charter	2,259 16
August 10, 1899, 5 per cent required by charter	2,297 94
August 14, 1900, 5 per cent required by charter	2,439 13
August 8, 1901, 5 per cent required by charter	2,454 67
August 7, 1902, 5 per cent required by charter	2,391 58
November 9, 1899, surplus funds	4,000 00
December 31, 1899, surplus funds	1,531 17
December 31, 1900, surplus funds	9,857 45
December 31, 1901, surplus funds	5,210 97
December 31, 1902, surplus funds	6,894 49
Total	<u>\$41,696 81</u>

HIGH SERVICE.

The consumption on the high service, as indicated by the pumping record of that station, was about eleven million gallons, or about 4% of that of the low service. Of this amount, about 85% was measured to consumers through meters; 3% was estimated to have been used where meters stopped, and where it was inexpedient to apply meters; 5% was the estimated loss in the motor, and about 7% remains unaccounted for.

About 83% of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 17% by the auxiliary steam plant.

METERS.

There are now in use 2,527 meters, an increase of 126 over last year.
Of the water pumped, about 54% has passed through meters yielding about 81% of the revenue.

Respectfully submitted,

F. H. CRANDALL, Superintendent.

TABLE No. 6.—ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.

Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	ODOR.		RESIDUE.			AMMONIA.		Chlorine	Hardness.
						Cold.	Floet.	Total Solids.	Loss on Ignition.	Fixed Solids.	Free.	Albuminoid.		
15277	1-1-02	1-1-02	Distinct.	Considerable.	10	Faint	Faint	68.0	6.0	57.0	.080	180	1.3	51.1
15242	1-8-02	1-8-02	Slight.	Very slight.	15	Distinct	Distinct	68.0	21.0	47.0	.080	114	1.3	46.2
15435	1-15-02	1-15-02	"	"	08	Very faint.	Very faint.	65.0	19.0	46.0	.018	106	1.3	45.7
15499	1-22-02	1-22-02	"	"	08	Faint.	Faint.	64.0	20.0	44.0	.012	106	1.3	44.7
15568	1-29-02	1-29-02	"	"	08	"	"	62.0	17.0	45.0	.006	116	1.1	43.7
15681	2-5-02	2-5-02	Very slight.	Very slight.	08	Very faint.	Very faint.	62.0	17.0	45.0	.023	104	1.3	45.0
15780	2-12-02	2-12-02	"	"	10	None.	None.	65.0	16.0	49.0	.046	116	1.3	42.9
15818	2-19-02	2-19-02	Very slight.	"	11	Faint.	Faint.	67.0	19.0	48.0	.012	110	1.4	47.8
15883	2-26-02	2-26-02	"	"	06	"	"	68.0	22.5	45.5	.008	090	1.3	44.3
15970	3-5-02	3-5-02	Slight.	Slight.	08	None.	None.	63.0	15.0	48.0	.014	126	1.3	42.9
16069	3-12-02	3-12-02	None.	Very slight.	08	Faint.	Faint.	64.0	21.0	43.0	.024	102	1.3	43.9
16163	3-19-02	3-19-02	Slight.	"	08	Very faint.	Very faint.	64.5	18.5	46.0	.024	118	1.3	41.6
16226	3-24-02	3-24-02	Distinct.	Slight.	08	None.	None.	62.0	25.0	37.0	.012	108	1.3	37.7
16270	3-28-02	3-28-02	Slight.	"	12	Faint.	Faint.	62.0	22.0	40.0	.018	112	1.4	39.0
16370	4-2-02	4-2-02	"	Very slight.	08	Distinct.	Distinct.	59.0	14.0	45.0	.018	108	1.5	42.9
16433	4-7-02	4-7-02	"	"	08	Faint.	Faint.	63.0	20.0	43.0	.040	102	1.1	41.6
16434	4-7-02	4-7-02	"	"	08	"	"	59.5	15.5	44.0	.028	124	1.3	41.6
16434	4-7-02	4-7-02	Distinct.	Slight.	08	"	"	65.0	17.0	48.0	.015	110	1.3	44.8
16435	4-7-02	4-7-02	Slight.	Very slight.	08	"	"	63.0	18.0	45.0	.012	104	1.2	43.9
16435	4-7-02	4-7-02	Distinct.	Slight.	08	"	"	61.0	18.0	43.0	.012	110	1.3	42.9
16437	4-7-02	4-7-02	"	"	08	"	"	65.0	16.0	49.0	.026	112	1.3	44.2
16453	4-9-02	4-9-02	"	"	08	"	"	69.0	18.0	51.0	.018	110	1.3	44.2
16580	4-17-02	4-17-02	"	Very slight.	08	Very faint.	Very faint.	60.5	20.5	40.0	.018	124	1.4	36.0

TABLE No. 6.—ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.—Continued.

Source.	BACTERIA.		Nitrogen as Nitrates.	Nitrogen as Nitrites.	Microscopically.	Remarks.
	No. per c. c.	No. Colon per c. c.				
Tap—Laboratory.....	400		.200	.000	Few <i>synedra</i> , small amt amor. and vegetable matter.....	Biolog. and chem. is a good quality..
" " ".....	100		.200	.000	Few diatoms and amorphous matter.....	" " " " " " " " " " " "
" " ".....	300		.190	.000	Few protozoa and diat. amor. mat..	" " " " " " " " " " " "
" " ".....	300		.190	.000	Negative.....	" " " " " " " " " " " "
" " ".....	800		.190	.000	Few <i>uruglens</i> , <i>asterionella</i> , etc.....	" " " " " " " " " " " "
" " ".....	800		.180	.000	Few diatoms.....	" " " " " " " " " " " "
" " ".....	1200		.210	.000	Few <i>asterionella</i>	" " " " " " " " " " " "
" " ".....	200		.300	.000	Few diatoms and amorphous matter.....	" " " " " " " " " " " "
" " ".....	200	Present.	.200	.000	Few diatoms and amorphous matter.....	C. is unob. B. shows pres. of the bacillus coli communis (sew. bacteria)
" " ".....	Con		.250	.000	Much amorphous matter.....	B. no. of bacteria is high. C. is unob.
" " ".....	1000		.280	.000	Small amt. of amorphous matter....	Biolog. and chem. is a good quality..
" " ".....	2200	Present.	.210	.000	Negative.....	C. is unob. B. shows pres. of the bacillus coli communis (sew. bacteria)
" " ".....	1000		.210	.000	Small amt. of amorphous matter....	C. is unob. B. shows pres. of the bacillus coli communis (sew. bacteria)
" " ".....	1500		.200	.000	Negative.....	C. is unob. B. shows pres. of the bacillus coli communis (sew. bacteria)
" " ".....	1000		.210	.000	Amorphous and crystalline matter..	Biolog. and chem. is a good quality..
" " ".....	900		.210	.000	Negative.....	" " " " " " " " " " " "
" " ".....	800		.210	.000	Vorticella, amorphous matter.....	" " " " " " " " " " " "
" " ".....	800		.210	.000	Few diatoms.....	" " " " " " " " " " " "
" " ".....	700		.210	.000	Negative.....	" " " " " " " " " " " "
" " ".....	1000		.210	.000	Negative.....	" " " " " " " " " " " "
" " ".....	1400		.200	.000	Negative.....	" " " " " " " " " " " "
Tap—Laboratory.....	900		.250	.000	Diatoms and amorphous matter.....	" " " " " " " " " " " "

TABLE No. 6.—ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH—Continued.

Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	ODOR.		RESIDUE.			AMMONIA.		Chlorine.	Hardness.
						Cold.	Hot.	Total Solids.	Loss on Ignition.	Fixed Solids.	Free.	Albuminoid.		
16660	4-25-02	4-23-02	Distinct.	Slight.	.09	Faint.	Faint.	52.0	32.0	42.0	.018	.130	1.3	41.6
16734	4-30-02	4-30-02	Slight.	Very slight.	.10	None.	None.	68.0	24.0	44.0	.012	.118	1.4	44.3
16815	5-7-02	5-7-02	"	"	.10	Faint.	Faint.	73.0	24.0	49.0	.014	.128	1.3	47.5
16897	5-14-02	5-14-02	Distinct.	Slight.	.08	Distinct.	Distinct.	69.0	19.0	50.0	.012	.114	1.3	48.7
16981	5-21-02	5-21-02	"	Very slight.	.08	Faint.	Faint.	71.0	19.0	52.0	.013	.138	1.1	48.6
17047	6-29-02	6-29-02	"	"	.10	Distinct.	Distinct.	62.0	17.0	45.0	.014	.116	1.3	44.3
17082	6-4-03	6-4-03	Slight.	"	.30	Distinct.	Distinct.	63.5	21.0	42.0	.024	.134	1.1	44.3
17176	6-11-02	6-16-02	Distinct.	"	.20	Decided.	Decided.	61.0	14.5	46.0	.033	.136	1.0	48.6
17288	6-18-02	6-18-02	"	"	.30	Distinct.	Distinct.	63.0	17.0	46.0	.013	.116	1.0	44.3
17306	6-25-02	6-25-02	Slight.	"	.30	Distinct.	Distinct.	63.0	17.0	46.0	.024	.132	1.1	47.0
17399	7-2-02	7-2-02	"	"	.20	Decided.	Decided.	70.5	13.5	57.0	.013	.143	.9	47.1
17456	7-11-02	7-11-02	"	"	.30	Faint.	Faint.	75.0	16.0	59.0	.018	.112	.9	51.4
17643	7-16-02	7-16-02	"	"	.20	Very faint.	Very faint.	64.0	16.0	48.0	.013	.130	1.0	47.1
17604	7-31-02	7-31-02	Slight.	Very slight.	.15	"	"	61.0	20.0	41.0	.023	.163	.9	42.9
17605	7-31-02	7-31-02	"	"	.15	"	"	59.0	12.5	46.5	.018	.134	.8	45.7
17680	7-31-02	7-31-02	"	Very slight.	.15	Faint.	Faint.	63.5	15.0	48.5	.013	.132	1.0	46.7
17687	7-29-02	7-31-02	"	Slight.	.15	"	"	67.0	18.0	49.0	.012	.138	1.1	50.0
17638	7-23-02	7-23-02	Distinct.	"	.15	"	"	64.0	26.0	43.0	.012	.124	.9	42.9
17689	7-30-02	7-30-02	"	"	.15	"	"	60.0	14.0	46.0	.012	.134	.8	45.7
17714	7-30-02	7-30-02	Slight.	Very slight.	.15	Faint.	Faint.	66.5	17.0	49.5	.006	.129	.9	50.0
17781	8-6-02	8-6-02	Distinct.	"	.14	Very faint.	Very faint.	65.0	13.5	51.5	.014	.118	.8	51.4
17867	8-13-02	8-13-02	"	Slight.	.12	Very faint.	Very faint.	70.0	15.0	55.0	.006	.123	1.0	55.7
17869	8-20-02	8-20-02	"	"	.14	Distinct.	Distinct.	63.0	17.0	46.0	.012	.119	.9	53.9

TABLE No. 6—ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.—Continued.

Source.	BACTERIA.		Nitrogen as Nitrates.	Nitrogen as Nitrites.	Microscopically.	Remarks.
	In one c. c.	B. coll. (coll per c.c.)				
Tap-Laboratory.....	600		.250	.000	Amorphous matter	Biolog. and chem. is a good quality..
" ".....	400		.300	.000	Few diatoms, some amor. matter....	" " " " " "
" ".....	300		.250	.000	Negative.....	" " " " " "
" ".....	400		.150	.000	Few ciliated protozoa and diatoms..	" " " " " "
" ".....	400		.240	.000	A few diatoms.....	" " " " " "
" ".....	100		.160	.000	Diatoms, veg. and amor. matter....	" " " " " "
" ".....	800		.170	.000	Few diatoms, synedra & amor. mat.	" " " " " "
" ".....	300		.250	.000	Amor. mat., inorganic crystals, diat.	" " " " " "
" ".....	300		.160	.000	Few diatoms and amorphous matter...	" " " " " "
" ".....	200		.170	.000	Amorphous and vegetable debris....	" " " " " "
" ".....	500		.180	.000	Many diatoms, few protozoa, amor- phous matter	" " " " " "
" ".....	600		.180	.000	Diatoms and amorphous matter.....	" " " " " "
" ".....	300		.200	.000	Negative.....	" " " " " "
" -325 Pearl St.....	100	Pres few	.200	.000	Small amt. amor. matter, diatoms..	C. is unob. B. shows pres. of the bac- cillus coli communis (sew. bacteria)
" -88 College St...	100	Pres. few	.200	.000	Amor. mat., diatoms, crys. mat....	C. is unob. B. shows pres. of the bac- cillus coli communis (sew. bacteria)
Tap-Laboratory.....	30		.200	.000	Few diatoms, asterionella & synedra.	Biolog. and chem. is a good quality..
" -Well-Pump 'g S	200		.160	.000	Negative.....	" " " " " "
" -Out of No. Res	200		.150	.000	Diatoms and amorphous matter....	" " " " " "
" -At So. Res.....	200	Pre	.150	.000	Protozoa, diatoms, amor. matter....	C. is unob. B. shows pres. of the bac- cillus coli communis (sew. bacteria)
Tap-Laboratory.....	200		.190	.000	Few diatoms and amor. matter....	Biolog. and chem. is a good quality..
" ".....	400		.180	.000	Few diatoms and amor. matter....	" " " " " "
" ".....	300		.170	.000	Few diatoms, amor. and veg. mat..	" " " " " "
" ".....	200	Pres.	.200	.000	Many asterionella and synedra.....	C. is unob. B. shows pres. of the bac- cillus coli communis (sew. bacteria)

TABLE No. 6.—ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH—Continued.

Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	ODOR.		RESIDUE.				AMMONIA.		Chlorine	Hardness.
						Cold.	Hot.	Total Solids.	Loss on Ignition.	Fixed Solids.	Free.	Albuminoid.			
18005	8-27-02	8-27-02	Slight.	Slight.	.12	None.	None.	68.0	25.0	41.0	.013	.142	1.0	41.4	
18163	9-10-02	9-12-02	Very slight.	Very slight.	.02	Very faint.	Very faint.	62.0	11.0	51.0	.018	.094	.9	51.4	
18334	9-17-02	9-17-02	Distinct.	Slight.	.10	Faint.	Faint.	67.6	25.0	42.0	.003	.104	1.2	42.9	
18800	9-24-02	9-24-02	"	Very slight.	.10	Faint veget.	Faint veget.	91.0	13.0	78.0	.013	.116	.8	57.1	
18334	10-1-02	10-1-02	Slight.	"	.10	None.	None.	68.0	16.5	51.5	.012	.110	1.1	51.4	
18486	10-8-02	10-8-02	Distinct.	"	.10	"	"	65.0	15.0	50.0	.012	.116	.8	52.9	
18483	10-15-02	10-15-02	"	Slight.	.25	"	"	65.0	17.0	48.0	.016	.118	.8	53.9	
18700	10-22-02	10-31-02	"	"	.23	"	"	57.0	17.0	40.0	.012	.122	.9	54.3	
18756	10-30-02	10-29-02	Slight.	"	.30	Faint.	Faint.	66.0	14.5	47.5	.013	.113	1.1	51.4	
18902	10-30-02	10-30-02	Decided.	"	.35	Very faint.	Very faint.	79.0	23.0	57.0	.012	.114	1.0	61.4	
18319	10-31-02	10-31-02	Slight.	"	.30	Dist. earthy.	Dist. earthy.	69.0	19.0	50.0	.008	.100	1.1	51.1	
18374	11-5-02	11-5-02	Distinct.	Very slight.	.35	N ne.	None.	65.0	23.5	41.5	.008	.114	1.1	60.0	
18178	11-12-02	11-12-02	"	"	.23	"	"	63.0	29.0	40.0	.004	.032	.9	52.9	
18078	11-19-02	11-19-02	"	"	.38	"	"	66.0	23.0	43.0	.006	.074	.9	51.9	
19165	11-26-02	11-26-02	"	"	.25	Very faint.	Very faint.	63.0	28.0	35.0	.006	.100	.9	57.1	
19249	12-8-02	12-8-02	"	"	.0	Faint-greasy.	Faint-greasy.	62.0	19.0	43.0	.002	.046	1.1	51.1	
18825	12-10-02	12-10-02	"	Slight.	.24	None.	None.	67.5	19.6	48.5	.001	.093	1.1	54.9	
19407	12-17-02	12-17-02	"	Very slight.	.25	Faint.	Faint.	61.0	20.5	43.5	.008	.068	1.1	54.3	
49174	12-22-02	12-22-02	"	"	.35	None.	None.	68.0	21.0	47.0	.013	.110	1.2	61.4	
18566	12-31-02	12-31-02	"	"	.35	Very faint.	Very faint.	67.0	18.0	49.0	.012	.106	1.2	8.5	

TABLE No. 6.—ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.—Concluded.

Source.	BACTERIA.		Nitrogen as Nitrates.	Nitrogen as Nitrites.	Microscopically.	Remarks.
	No. per c. c.	No. Colon per c. c.				
Tap-Laboratory	100	Present.	.180	.000	Few asterionella and amor. matter..	C. is unob. E. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	500	Present.	.170	.000	Snyedra and diatoms.....	C. is unob. E. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	300		.150	.000	Many aster. and snyedra, few uru- glen and amorphous matter.....	C. is unob. E. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	700		.270	.000	Diatoms and amorphous matter.....	Biolog. and chem. is a good quality..
"	100	Present.	.180	.000	Negative.....	C. is unob. E. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	1600	Present.	.180	.000	Many diatoms, aster. and snyedra..	C. is unob. E. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	400		.150	.000	Diatoms, few ciliated prot. am. mat.	Biolog. and chem. is a good quality..
"	800	Present.	.170	.000	Few diatoms	C. is unob. E. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	400		.190	.000	Few protozoa	Biolog. and chem. is a good quality..
"	1500		.200	.000	Few protozoa and amor. matter....	P. and C. shows excess amt. org mat.
"	1600	Present.	.210	.000	Few protozoa and amor. matter....	C. is unob. E. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	200	Present.	.200	.000	Negative.....	C. is unob. P. shows pres. of the bac- cillus coli communis (sew. bacteria)
"	400		.230	.000	Not examined.	Biolog. and chem. is a good quality..
"	300		.180	.000	Asterionella and snyedra.....	" " " " " "
"	800		.150	.000	Negative.....	" " " " " "
"	600		.150	.000	Diatoms.....	" " " " " "
"	600		.200	.000	Diatoms.....	" " " " " "
"	300		.200	.000	Snyedra and asterionella.....	" " " " " "
"	1400		.200	.000	Amorphous matter and diatoms....	" " " " " "
"	1000		.180	.000	Few diatoms, aster. and snyedra....	" " " " " "

FINANCIAL.

Division I.

MAINTENANCE.

RECEIPTS.

EXPENDITURES.

From Consumers:	
A. Water rates, domestic.....	\$34,079.93
B. Water rates, mfg.....	2,742.69
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C. Net receipts for water.....	\$36,822.63
D. Miscellaneous	3,440.06
<hr/>	
E. Total	\$40,262.69
Total from public funds:	
F. Hydrants	\$3,480.00
G.*Fount. and pks..	244.50
H.*St. watering.....	1,425.82
I.* Public buildings..	514.01
Water troughs.....	237.50
Other public use..	93.02
<hr/>	
	\$ 5,994.85
<hr/>	
K. Gross receipts from all sources	\$46,257.53

AA. Management and repairs.	
Repl. cement.....	\$3,882.01
Current	9,760.67
Pumping ..	8,669.55
Meters	3,589.12
	<u>\$30,891.35</u>
BB. Interest on bonds.....	9,920.00
CC. Total maintenance.....	\$40,811.35
DD. Bal. to Con.....	\$1,174.17
Bal. to S. F.....	4,272.01
	<u></u>
Total balance	\$ 5,446.18
	<u></u>
EE. Total	\$46,257.58

*Paid at meter rates.

Division II.

From fixed rates.

L. Domestic	\$8,246 09
M. Manufacturing	
	<hr/>
N.	\$8,246 09
O. Domestic	\$31,828 69
	<hr/>
P. Manufacturing	2,742 69
Q.	\$34,571 38
	<hr/>
Total	\$42,817 47

CONSTRUCTION.

RECEIPTS.

DISBURSEMENTS.

T. Trans from Cur. App.....\$1,174.17

V. Total\$1,174.17

GG. Extension of services..	276.
FF. Extension of mains.....	\$ 897.80
GG. Extension of services...	276.37
KK. Total	<u>\$1,174.17</u>

W. Cost of works to date	\$475,635 40
X. Bonded debt at date	248,000 00
Y. Value of sinking fund at this date, about	44,000 00
Z. Rate of interest, four per cent.	

CONSUMPTION.

1. Estimated total population at date, 19,200.
2. Estimated total population on lines of pipe, 18,700.
3. Estimated total population supplied, 18,600.
4. Total number of gallons consumed for year, 293,386,475.
5. Passed through domestic meters, 142,536,825 gallons, or 49 per cent.
6. Passed through manufacturing meters, 15,112,500 gallons, or 5 per cent.
7. Average daily consumption, 803,798 gallons.
8. Gallons per day to each inhabitant, 41.
9. Gallons per day to each consumer, 43.
10. Gallons per day to each tap, 232.

DISTRIBUTION.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Galvanized iron, cast iron and lead.
2. Size from 4 to 30 inches.	17. From one-half to six inches.
3. Extended, 4,835 feet.	18. 1,536 feet.
4. Discontinued, 2,244 feet.	19. 73 feet.
5. Total now in use, about 39 miles.	20. 18.8 miles or 99,325 feet.
6. Cost of repairs per mile, \$8.18.	21. Service taps added, 44.
7. Leaks per mile, .7.	22. Number now in use, 3,464.
8. Small distribution pipes less than four inch, total length, 14,195 feet.	23. Average length of services, 29 feet.
9. Hydrants added, 1.	24. Average cost of services, \$7.80.
10. Number now in use, 214.	25. Meters added, 126.
11. Stop-gates added, 19.	26. Meters now in use,
12. Number now in use, 652.	a. domestic 2,465
13. Small stop-gates less than four-inch, total 60.	b. manufacturing 42
14. Number of blow-off gates, 14.	Total 2,527
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.	27. Motors and elevators added, 0.
	28. Number now in use, 35.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons; iron tank, high service, capacity 169,617 gallons.

1903.



Thirty-Seventh Annual Report

OF THE

Water Department

OF THE

CITY OF BURLINGTON, VT.

AND OF THE

Water Commissioners

The Fifteenth.

DECEMBER 31, 1903.

BURLINGTON :
FREE PRESS ASSOCIATION
1903

Thirty-Seventh Annual Report

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BURLINGTON :
FREE PRESS ASSOCIATION
1908

COMPLIMENTS OF
F. H. CRANDALL, 57 PT
PLEASE EXCHANGE

COMPLIMENTS OF
RANDALL

BOARD OF WATER COMMISSIONERS.

J. W. GOODELL, Chairman, (Term expires 1904).

J. J. FLYNN, (Term expires 1905).

J. E. LANOU, (Term expires 1906).

OFFICERS.

FRANK H. CRANDALL, C. E., Superintendent.

MISS F. P. EADY, Registrar.

MISS K. M. McCAFFREY, Office Assistant.

JOEL W. THOMAS, Engineer at Pumping Station.

WILLIAM CASSIDY, Foreman.

OSCAR HEININGER, Chief Inspector.

FIFTEENTH ANNUAL REPORT

OF THE

WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

Gentlemen:—The Board of Water Commissioners, as required by City Ordinance, submit their report for the year ending December 31, 1903.

There has been collected by the Water Department for service rates during the year, \$43,199.68, and with the reduced rates of June 1, 1902, in force during all of the past year, show an increase of \$382.21 in the receipts of the department.

The unpaid bills, for service rates, are \$190.58 in amount; nearly all of which will be collected.

The water is now shut off for non-payment at four places, one of which was of the number reported one year ago.

The good condition of the reservoirs has been fully maintained, and some improvements made, especially in the better facilities for cleaning in a thorough manner.

The Pumping Station has not been allowed to deteriorate, and some conveniences, for the work of the Department, have been provided. The extremely dry weather, of some parts of the year, caused the use of an unusual amount of water, but the pumps have continued to render fairly good service, and at no time has there been any lack of supply in the reservoirs.

All orders of the City Council for new work have been fully executed, and all such extensions are now in use.

The enlargement of the Water Works, by extensions or branches that are not self supporting, or prospectively soon to be so, is, to say the least, a questionable policy, as it increases the cost of main-

tenance with no corresponding increase in the receipts of the Department, and might soon make it necessary to charge a higher service rate if our Water Works are to continue self supporting.

The amount of cement pipe replaced by iron pipe during the year has not been large, and there is still a considerable amount of such work to be done when all the conditions are favorable for it.

The sum of \$42,817.47 being the amount received from service rates in 1902, and by Charter provided for distribution during the year 1903, although more than \$5,000.00 less than the preceding year, has with the sum of \$4,061.43, received for material and labor, been made by the Department to pay all current expenses, interest on all water bonds, and in addition to the Charter requirement of five per cent. of receipts, add a very small sum to the Sinking Fund.

We herewith submit the report of the Superintendent, and respectively refer you to that for details and other information of the department.

It is a pleasure to gratefully acknowledge the pleasant relations existing, and the uniform courtesy extended to this Board by your Honorable Body during the past year.

Respectively submitted,

J. W. GOODELL,	} Water
JOHN J. FLYNN,	
J. E. LANOU,	
	Commissioners.

THIRTY-SEVENTH ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS.

To the Honorable Board of Water Commissioners of the City of Burlington, Vt.:

Gentlemen:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1903.

RECEIPTS.

From L. C. Grant, City Treasurer:

Amount of transfer to sinking fund required....	\$ 2,140 87
Amount of transfer to construction account.....	869 31
Balance of appropriation for current expenses...	39,807 29

Total amount of appropriation	\$42,817 47
Amount received from material and labor.....	4,061 43

Total receipts from City Treasurer.....\$46,878 90

DISBURSEMENTS.

Construction—

Cast iron pipe	\$500 00
Labor	369 31

Total construction..... \$869 31

<i>Current—</i>	MAINTENANCE.
Pay rolls	\$4,560 87
Pipe and castings	3,441 96
Salary of Superintendent	1,400 00
Reservoir cleaning and repairs	1,384 66
Gates and check valves	565 41
Pig lead	563 08
Salary of Registrar	540 00
Material for management and repairs.....	538 51
Stable expenses	480 21
Rent and sprinkling tax	404 62
Hydrant repairs	302 24
Salary of Water Commissioners.....	300 00
Tank cleaning and repairs	297 66
Wrought iron pipe and plugs	238 72
Horse and harness	181 50
Repair of tools	147 64
Printing, advertising and postage	125 95
Telephone rent	79 26
Office expenses	70 44
Report on electrolysis	50 00
Damages	24 90
Water tax refunded by order of City Council.....	1 04
<i>Interest—</i>	<hr/> \$15,698 67
Interest on debt	\$ 9,920 00

PUMPING

<i>Low Service Station—</i>	
Fuel	\$ 5,040 78
Pay rolls	2,778 34
Holisting engine	640 90
Repairs to machinery	300 42
Electric light plant	154 43
Oil and packing	106 58
Repairs to building	82 01
Insurance	67 50
Gas	64 08
Repair of tools and supplies	43 04
	<hr/>
	\$ 9,278 08

WATER DEPARTMENT.

7

High service station—

Repairs to building	\$150 10
Station pay roll	130 09
Fuel and light	27 98
	<hr/> \$ 308 17

Steam pump—

Fuel	\$ 82 96
Repairs and care	66 80
	<hr/> \$ 149 76

Motor—

Pay rolls	\$120 15
Repairs	86 60
	<hr/> \$ 206 75

\$ 664 68

\$ 9,942 76

METERS.

Pay rolls	\$ 2,361 31
Meters	1,719 48
Material for repairs	371 45
	<hr/> \$ 4,452 24

Total maintenance\$40,013 67

TRANSFERS.

To sinking fund, 5% required by charter.....	\$ 2,140 87
To poor farm water supply by order of C. C.....	2,985 74
Sinking fund, surplus funds	869 31
	<hr/>
Total transfers	\$ 5,995 92
	<hr/>
Total disbursements	\$46,878 90

RECAPITULATION.

RECEIPTS.

From L. C. Grant, City Treasurer	\$46,878 90
--	-------------

DISBURSEMENTS.

Maintenance—

Current	\$15,698 67
Pumping	9,942 76
Meters	4,452 24

\$30,093 67

Interest	9,920 00
----------------	----------

Total maintenance	\$40,013 67
-------------------------	-------------

Transfers	5,995 92
-----------------	----------

Construction	869 31
--------------------	--------

Total disbursements\$46,878 90

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates	\$ 7,712 09
----------------------	-------------

Meter rates	35,487 59
-------------------	-----------

Total receipts\$43,199 68

DISBURSEMENTS.

L. C. Grant, City Treasurer	\$43,199 68
-----------------------------------	-------------

UNPAID WATER RATES.

Meter rates, twenty-three in number	\$146 49
---	----------

Schedule rates, twelve in number.....	44 09
---------------------------------------	-------

Total unpaid water rates forward to 1904.....\$ 190 58

POOR FARM WATER SUPPLY.

RECEIPTS.

From L. C. Grant, City Treasurer.....	\$ 4,295 94
---------------------------------------	-------------

DISBURSEMENTS.

Pay rolls	\$2,190 41
-----------------	------------

Wrought iron pipe and fittings	1,127 21
--------------------------------------	----------

Cast iron pipe	545 68
----------------------	--------

Tools and supplies	297 85
Lead, yarn and specials	74 79
Hydrants and gates	60 00
	<hr/> \$ 4,295 94

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1903, of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

We also find that the provision of the water ordinance, relative to collection of water rates, discount, penalty, etc., have been fairly and impartially administered.

THOMAS FAILEY,	} Auditors.
W. H. ROBERTS,	
M. C. GRANDY,	

Statement of assessments and current expenditures for year ending December 31, 1903.

The paid assessments of this statement are the receipts for the year, less whatever portion of the same was assessed previous to January 1, 1903. The unpaid are the unpaid of January 1, 1904, less whatever portion of the same are of more than one year's standing.

ASSESSMENTS.

DISBURSEMENTS.

<i>Paid.</i>		Interest	\$ 9,920 00
Meter rates ..	\$35,425 91	Current	\$15,698 67
Sched. rates .	7,712 09	Pumping	9,942 76
	<hr/>	Meters	4,452 24
	\$43,138 00		<hr/> 30,093 67
Mat. and labor	4,061 43		
	<hr/> \$47,199 43		<hr/> \$40,013 67
<i>Unpaid.</i>		Excess of assessments	
Meter rates...\$	138 77	over disbursements for	
Sch. rates...	44 09	the year 1903.....	\$ 7,371 22
Mat. and labor	2 60		<hr/>
	<hr/> 185 46		
	\$47,384.89		<hr/> \$47,384 89

WATER PUMPED.

1903.	Gallons.
January	21,078,150
February	20,391,050
March	21,306,275
April	20,222,825
May	36,623,900
June	35,146,075
July	30,116,575
August	28,099,575
September	32,633,375
October	25,003,700
November	23,808,125
December	25,033,575
<hr/>	
Total 1903	319,463,200
Total 1902	293,386,475
<hr/>	
Increase in 1903	26,076,725
Daily average in 1903	875,241
Daily average in 1902	803,798

SERVICES.

There have been added 70 services of the following sizes:

Fifty-one	1/2 inch.
Seven	3/4 inch.
Four	1 inch.
One	1 1/2 inch.
Six	2 inch.
One	4 inch.

Of the above, eight services replace old ones. Two 1/2 inch services have been discontinued.

HYDRANTS.

There have been set, during the past year, one new public hydrant on North avenue at Institute road, and one new private hydrant in the pumping station yard. During the progress of the season's work, Mr. E. W. Peck's private hydrant was moved to the curb line.

Total number of public hydrants.....	178
Total number of private hydrants.....	38
Total	216

SUPPLY PIPE.

Small distribution pipe has been laid as follows:	Feet.
North avenue, northerly from end of; 6 inch with 2 inch galvanized iron	5,487
Williams street, southerly from College street; main with 2 inch galvanized iron	165
In other than public highways:	
*Nash place, westerly from Colchester avenue; with 1¼ inch galvanized iron	303
*Fletcher place, westerly from Colchester avenue; with 1¼ inch galvanized iron	240
On premises of B. H. Porter; with 2 inch galvanized iron.....	185
On premises of B. H. Porter and City Poor Farm; with 1½ inch galvanized iron	2,163
Making a total length of supply pipe now in use.....	22,738

MAINS.

New mains have been laid as follows:

With 6 inch cast iron pipe.

	Feet.
North avenue, northerly from dead end	1,170
North lumber yard at station	294

Total length of new mains.....	1,464
The 10 inch cement pipe in College street, westerly from Willard street, has been replaced with cast iron pipe of the same size	460

LENGTH OF PIPE NOW IN USE.

Cement	29,238 feet.	About 6 miles.
Cast iron	179,334 feet.	About 33 miles.
Total	208,572 feet.	About 39 miles.

*Pipe laid at the expense of the individual.

GATES.

Gates have been set in the following locations:

In station yard	2	10 inch.
In station yard	5	6 "
North avenue near Institute well	1	6 "
North avenue, north line of Institute road	1	6 "

Total 9

Total number now in use.....661

Valves have been placed on supply pipe as follows:

Williams street at south line of College street.....	1	2 inch.
North avenue, at end of 6 inch.....	1	2 "
North avenue, at south line of school property.....	1	2 "
North avenue, on blow-off at end of line.....	1	2 "
Fletcher place, at Colchester avenue.....	1	1¼ "
Nash place, at Colchester avenue.....	1	1¼ "
Total	6	

Total number now in use..... 66

REPAIRS.

The repairs for the year have been:

On cement pipe	1 break.
On cement pipe	2 pick holes.
On iron pipe	7 joint leaks.
On iron pipe	1 leak.
On service pipe	15 leaks.

ELECTROLYSIS.

Facilities have been provided, on the Winooski hill, for the accurate measurement, both of the quantity and pressure of the electric current making its return to the power station of the Traction Company by way of the water mains.

No breaks have occurred during the season, which could be traced to electrolysis, and at the time when observations were made, no material variation from the conditions noted in former years was detected.

A six inch cast iron main was, during the season, laid from Loomis street, southerly opposite Booth street, a distance of 597 feet, for and at the expense of W. C., A. S. and E. S. Isham.

The understanding in regard to the extension is that should this proposed street be accepted, and the laying of a water main therein ordered by the City Council, the Water Department will purchase the pipe laid at the price paid to the department for the same, viz., five hundred dollars.

The above is now yielding an income of about three and one-half per cent. The Cliff street extension about the same.

SINKING FUND.

Deposits to this fund have been made with the City Treasurer as follows:

Dec. 31, 1899, construction account for the year.....	\$2,726 42
Dec. 31, 1900, construction account for the year	2,200 00
Dec. 31, 1901, construction account for the year.....	6,421 50
Dec. 31, 1902, construction account for the year.....	1,174 17
Dec. 31, 1903, to apply on North avenue extension account	2,985 74
To be applied in reduction of the bonded debt—	
Sept. 10, 1897, 5 per cent. required by charter.....	\$2,360 25
Aug. 4, 1898, 5 per cent. required by charter.....	2,259 16
Aug. 10, 1899, 5 per cent. required by charter.....	2,297 94
Aug. 14, 1900, 5 per cent. required by charter.....	2,439 13
Aug. 8, 1901, 5 per cent. required by charter.....	2,454 67
Aug. 7, 1902, 5 per cent. required by charter.....	2,391 58
Aug. 5, 1903, 5 per cent required by charter.....	2,140 87
Nov. 9, 1899, surplus funds	4,000 00
Dec. 31, 1899, surplus funds	1,531 17
Dec. 31, 1900, surplus funds	9,857 45
Dec. 31, 1901, surplus funds	5,210 97
Dec. 31, 1902, surplus funds	6,894 49
Dec. 31, 1903, surplus funds	869 31
Total	\$44,706 99

HIGH SERVICE.

The consumption on the high service, as indicated by the pumping record of that station, was about twelve million gallons, or about 4

per cent. of that of the low service. Of this amount, about 93 per cent. was measured to consumers through meters; 5 per cent. was the estimated loss in the motor, and about 2 per cent. remains unaccounted for.

About 71 per cent. of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 29 per cent. by the auxiliary steam plant.

METERS.

There are now in use 2,680 meters, an increase of 153 over last year.

Of the water pumped, about 59 per cent has passed through meters yielding about 82 per cent. of the revenue.

Respectfully submitted,

F. H. CRANDALL, Superintendent.

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.

Parts in 1,000,000				Odor		Color	Sediment	Turbidity	Examined	Collected	Number		
Residue		Ammonia		Chlorine	Hardness							Nitrogen as Nitrates	Nitrogen as Nitrites
Total solids	Loss on Ignition	Fixed Solids	Free										
Hot	Cold												
Very faint	Very faint	70.0	18.0	52.0	.006	.082	1.0	55.7	.000				
Faint	Faint	60.0	20.0	40.0	.012	.092	1.1	54.2	.000				
None	None	64.5	21.5	43.0	.006	.100	1.1	54.3	.000				
Very faint	Very faint	54.5	21.0	33.5	.004	.068	1.1	51.4	.000				
Faint	Faint	66.0	28.0	38.0	.004	.088	1.1	52.9	.000				
None	None	71.5	25.5	46.0	.006	.104	1.1	47.1	.000				
Faint	Faint	57.0	21.0	36.0	.012	.106	1.1	47.1	.000				
None	None	70.0	21.0	49.0	.014	.112	1.1	47.1	.000				
Very faint	Very faint	62.0	20.0	42.0	.012	.114	1.0	45.7	.000				
None	None	66.5	19.0	47.5	.012	.100	.9	51.4	.000				
None	None	66.0	18.5	47.5	.014	.108	.9	51.4	.000				
"	"	66.0	22.5	43.5	.006	.116	1.1	48.6	.000				
"	"	71.5	24.0	47.5	.018	.114	1.0	54.3	.000				
Very faint	Very faint	64.5	20.5	44.0	.014	.120	.9	44.8	.000				
Faint veget.	Faint veget.	64.0	14.0	50.0	.012	.136	.9	52.9	.000				
None	None	61.0	28.0	33.0	.012	.148	1.1	47.1	.000				
Very f't veg.	Very f't veg.	70.0	28.0	42.0	.018	.140	.9	54.3	.000				
None	None	66.5	20.0	39.5	.004	.102	.9	51.1	.000				
Very faint	Very faint	68.0	18.0	50.0	.064	.146	1.1	50.9	.000				
Faint	Faint	66.0	18.0	47.0	.018	.136	1.0	48.6	.000				
None	None	67.5	18.5	49.0	.016	.154	1.2	47.1	.000				
Dist. fishy	Dist. fishy	66.0	20.0	46.0	.064	.140	1.2	41.4	.000				
Decid'd fishy	Decid'd fishy	68.5	15.5	53.0	.016	.118	1.0	52.9	.000				
Faint veget.	Faint veget.	91.5	27.0	64.5	.016	.112	1.0	48.6	.000				

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.

continued.

Source	Bacteria		Microscopically	Remarks
	Bacteria In one c. c.	B. Coll B. Coll Per c. c.		
Tap at Laboratory	800 Pres.		Synedra, asterionella, infusoria.....	Chem. is unobjct: biol. shows the pres. of
" " "	400		Not examined.....	the bacillus coli communis (sew. bact.).....
" " "	500		Negative.....	Biologically and chemically is a good quality
" " "	400		Small amount amorphous matter.....	" " " " " "
" " "	1300		Diatoms.....	" " " " " "
" " "	400		Negative.....	" " " " " "
" " "	200		Few diatoms.....	" " " " " "
" " "	400		Amorphous matter.....	" " " " " "
" " "	500		Negative.....	" " " " " "
" " "	1800		Amorphous matter.....	" " " " " "
" " "	500		Negative.....	" " " " " "
" " "	1100		" " " " " "	" " " " " "
" " "	3400		" " " " " "	Chem. unobjct: biol. the number of bacteria
" " "	1800		Few algae.....	is high.....
" " "	700		Amorphous matter.....	Biologically and chemically is a good quality
" " "	100		Negative.....	" " " " " "
" " "	200		" " " " " "	" " " " " "
" " "	1300		Algae, diatoms (asterionella and synedra).....	Chem. is unobjct: biol. shows the pres. of the
" " "	400		Few diatoms.....	bacillus coli communis (sew. bact.).....
" " "	500		Amorphous matter, few protozoa.....	Biologically and chemically is a good quality
" " "	100		Negative.....	Biologically is unobjct: chem. suspicious....
" " "	200		" " " " " "	Biologically and chemically is a good quality
" " "	600		" " " " " "	Biol. is unobjct: chem. the high amt. of am-
" " "	300 Pres.		Amor. matter and diatoms, asterionella, etc.	monia is suggestive.....
				Biologically and chemically is a good quality
				Chem. unobjct: biol. shows the pres. of the
				bacillus coli communis (sew. bact.).....

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.

continued.

Number	Collected	Examined	Turbidity	Sediment	Color	Odor		Residue				Ammonia	Chlorine	Hardness	N Nitrogen as Nitrates	Nitrogen as Nitrates
						Cold	Hot	Total Solids	Loss on Ignition	Fixed Solids						
22854	7-1-08	7-1-08	Distinct	Very slight	20 Faint	Faint	Faint	58.5	9.0	49.5	.014	.118	1.0	48.6	.000	.000
22460	7-8-08	7-8-08	Slight	Slight	20 D'st aromatic	D'st aromatic		65.0	21.5	43.5	.012	.116	.9	41.1	.180	.180
22544	7-15-08	7-15-08	Distinct	Very slight	32 F't aromatic	F't aromatic		60.0	34.0	26.0	.008	.180	1.1	51.4	.160	.000
22651	7-22-08	7-22-08	"	"	20 Faint	Faint		69.0	28.0	41.0	.008	.102	1.2	51.4	.160	.000
22720	7-29-08	7-29-08	"	"	24 Faint	Faint		69.0	18.5	50.5	.008	.122	1.0	51.4	.180	.000
22812	8-4-08	8-4-08	"	"	20 D'st aromatic	D'st aromatic		72.0	19.0	53.0	.008	.186	1.0	52.9	.170	.000
22868	8-19-08	8-19-08	"	Slight	20 D'st aromatic	D'st aromatic		62.5	30.0	32.5	.008	.182	1.2	56.7	.180	.000
23063	8-26-08	8-26-08	"	Very slight	16 Faint	Faint		68.0	18.0	50.0	.008	.114	1.1	56.7	.220	.000
23126	9-2-08	9-7-08	"	"	26 D'st aromatic	D'st aromatic		64.5	9.5	45.0	.012	.124	1.1	52.9	.170	.000
23331	9-16-08	9-16-08	"	"	20 Faint	Faint		62.0	30.0	32.0	.008	.100	1.1	50.0	.170	.000
23445	9-23-08	9-23-08	"	Slight	16 " "	" "		66.0	18.0	48.0	.014	.120	1.1	60.0	.160	.000
23669	10-7-08	10-7-08	"	"	16 " "	" "		67.0	17.0	50.0	.018	.120	1.0	50.0	.170	.000
23745	10-14-08	10-14-08	"	"	18 " "	" "		68.5	22.0	46.5	.008	.100	1.1	58.0	.160	.000
23838	10-21-08	10-21-08	"	Very slight	16 " "	" "		68.5	15.5	53.0	.008	.112	.9	51.1	.180	.000
23926	10-28-08	10-28-08	"	"	20 V. f't veget.	V. f't veget.		72.0	19.0	53.0	.008	.116	1.2	50.0	.200	.000
24067	11-4-08	11-4-08	"	"	21 Faint	Faint		67.0	30.0	47.0	.008	.112	1.1	47.0	.170	.000
24216	11-11-08	11-11-08	"	"	26 V. f't veget.	V. f't veget.		58.0	14.0	44.0	.006	.112	1.1	50.0	.150	.000
24394	11-18-08	11-18-08	"	"	17 Faint	Faint		70.0	16.0	54.0	.002	.092	1.0	54.3	.220	.000
24581	11-25-08	11-25-08	"	"	15 None	None		57.0	24.0	33.0	.008	.118	1.0	46.0	.210	.000
24670	12-2-08	12-2-08	"	"	16 " "	" "		71.0	19.0	52.0	.002	.086	1.2	51.4	.150	.000
24794	12-9-08	12-9-08	"	"	15 V. f't veget.	V. f't veget.		72.0	19.0	53.0	.008	.098	1.1	54.0	.200	.000
24923	12-16-08	12-16-08	"	Slight	18 None	None		66.0	15.0	51.0	.002	.098	1.4	54.3	.190	.000
25081	12-23-08	12-23-08	"	"	20 V. f't veget.	V. f't veget.		71.0	23.0	48.0	.006	.140	1.2	47.1	.230	.000
25127	12-30-08	12-30-08	"	Very slight	20 V. f't veget.	V. f't veget.		71.0	30.0	51.0	.006	.188	1.4	48.6	.230	.000

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.
concluded.

Source	Bacteria			Microscopically	Remarks
	Bacteria In one c. c.	B. Coll	B. Coll per c. c.		
Tap at Laboratory	1000			Amorphous matter.....	Biologically and chemically is a good "quality
"	200			"	Biologically and chem. is unobjectionable....
"	100			Negative.....	Biologically and chemically is a good "quality
"	500			Many diatoms, some amorphous matter.....	"
"	300			Negative.....	"
"	300			"	"
"	300			"	"
"	400			"	"
"	300			"	"
"	400	Neg.		"	Chem. is unobj. biol. shows the pres. of the bacillus coli communis (sew. bact.).....
"	300	Pres.		"	Chem. is unobj. biol. shows the pres. of the bacillus coli communis (sew. bact.).....
"	400			"	Biologically and chemically is a good "quality
"	1000			"	"
"	300	N'ne		Amorphous matter (small amount).....	"
"	300			Amorphous matter.....	"
"	100			Negative.....	"
"	2000	Pres.		"	Chem. is unobj. biol. shows the pres. of the bacillus coli communis (sew. bact.).....
"	200	"		"	Chem. is unobj. biol. shows the pres. of the bacillus coli communis (sew. bact.).....
"	700			Small amount of amorphous matter.....	Biologically and chemically is a good "quality
"	100			Negative.....	Biologically and chem. is unobjectionable....
"	1900	Pres.		Amorphous matter.....	Chem. is unobj. biol. shows the pres. of the bacillus coli communis (sew. bact.).....
"	600			Negative.....	Biologically and chemically is a good "quality
"	1500			Amorphous matter.....	"
"	300			"	"

1903.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.
Burlington, Chittenden County, Vermont.
Population by U. S. census, 1900, 18,640.
Works constructed 1867-8.
Owned by City.
Source of supply, Lake Champlain.
Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description (b) Bituminous.
of (d) Nonpareil
fuel (e) \$4.10.
6. Total pumpage for the year, 319,463,200 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
Cost of pumping, figured on Pumping Station expenses, viz., \$9,-
942.76.
11. Per million gallons raised against dynamic head into reservoir,
\$31.16.
12. Per million gallons raised one foot high (dynamic), \$.098.
Cost of pumping, figured on total maintenance, viz., \$40,013.67.
13. Per million gallons raised against dynamic head into reservoir,
\$125.43.
14. Per million gallons raised one foot high (dynamic), \$0.396.

FINANCIAL.

Division I.

MAINTENANCE.

RECEIPTS.

EXPENDITURES.

From consumers:		AA. Management and repairs.	
A. Water rates, domestic.....	\$33,911.09	Current.....	\$15,098.67
B. Water rates, mfg.....	2,627.68	Pumping.....	9,942.76
		Meters.....	4,452.24
C. Net receipts for water.....	86,588.77		\$30,098.67
D. Miscellaneous.....	4,061.43	BB. Interest on bonds.....	9,920.00
E. Total.....	\$40,600.20	CC. Total maintenance.....	\$40,018.67
From public funds:		DD. Bal. to con.....	\$ 869.31
F. Hydrants.....	\$3,540.00	Bal.....	6,378.18
G.* Fount. and pks....	261.69		
H.* St. watering.....	2,046.29	Total balance.....	\$7,247.44
I.* Public bldgs.....	478.80		
Water troughs.....	287.50		
Other pub. use.....	96.68		
	\$ 6,660.91		
K. Gross receipts from all sources.....	\$47,261.11	Total.....	\$47,261.11

Division II.

From fixed rates.

L. Domestic	\$ 7,712 09
M. Manufacturing	
N.	\$ 7,712 09

From meter rates.

O. Domestic	\$32,859 91
P. Manufacturing	2,627 68
Q.	\$35,487 59
Total.....	\$43,199 68

CONSTRUCTION.

RECEIPTS.

DISBURSEMENTS.

T. Trans. from Cur. App...\$869 31	GG. Exten. of services....\$869 31
V. Total .....\$869 31	KK. Total .....\$869 31
W. Cost of works to date	\$476,504 71
X. Bonded debt at date	248,000 00
Y. Value of sinking fund at this date, about.....	49,000 00
Z. Rate of interest, four per cent.	

* Paid at meter rates.

CONSUMPTION.

1. Estimated total population at date, 19,400.
2. Estimated total population on lines of pipe, 18,900.
3. Estimated total population supplied, 18,800.
4. Total number of gallons consumed for year, 319,463,200.
5. Passed through domestic meters, 175,567,500 gallons, or 55 per cent.
6. Passed through manufacturing meters, 15,685,500 gallons, or 4 per cent.
7. Average daily consumption, 875,241 gallons.
8. Gallons per day to each inhabitant, 45.
9. Gallons per day to each consumer, 46.
10. Gallons per day to each tap, 248.

MAINS.

DISTRIBUTION.

SERVICES.

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Kind of pipe, cement lined, cast iron, wrought iron. 2. Size from 4 to 30 inches. 3. Extended, 1,924 feet. 4. Discontinued, 460 feet. 5. Total now in use, about 39 miles. 6. Cost of repairs per mile, \$3.19. 7. Leaks per mile, .3. 8. Small distribution pipe, less than four inch, total length, 22,738 feet 9. Hydrants added, 2. 10. Number now in use, 216. 11. Stop-gates added, 9. 12. Number now in use, 661. 13. Small stop-gates less than four inch, total 66. 14. Number of blow-off gates, 14. 15. Range of pressure on mains at center, for day and night, 70 to 85 pounds. | <ol style="list-style-type: none"> 16. Galvanized iron, cast iron and lead. 17. From one-half to six inches. 18. 1,820 feet. 19. 260 feet. 20. 19.1 miles or 100,885 feet. 21. Service taps added, 60. 22. Number now in use, 3,524. 23. Average length of services, 26 feet. 24. Average cost of services, \$8.81. 25. Meters added, 153. 26. Meters now in use, <ol style="list-style-type: none"> a. domestic 2,640 b. manufacturing 40 <li style="text-align: right;">Total..... 2,680 27. Motors and elevators added, 0. 28. Number now in use, 35. |
|---|--|

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons; iron tank, high service, capacity 169,617 gallons.

THIRTY-EIGHTH ANNUAL REPORT

OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.

AND OF THE

WATER COMMISSIONERS

THE SIXTEENTH.

December 31, 1904.

BURLINGTON :
FREE PRESS ASSOCIATION,
PRINTERS, BINDERS, STATIONERS.
1905.

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1905.

BOARD OF WATER COMMISSIONERS.

J. E. LANOU, Chairman (Term expires 1906).

J. J. FLYNN, (Term expires 1905).

T. F. CONLON, (Term expires 1907).

OFFICERS.

FRANK H. CRANDALL, C. E., Superintendent.

Miss F. P. EADY, Registrar.

Miss K. M. McCaffrey, Office Assistant.

JOEL W. THOMAS, Engineer at Pumping Station.

WILLIAM CASSIDY, Foreman.

SIXTEENTH ANNUAL REPORT

OF THE

WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

GENTLEMEN:—The Board of Water Commissioners, as required by city ordinance, submit their report for the year ending December 31, 1904.

The receipts from water rates for the year have been \$45,099.60, an increase of \$1,899.92 over the receipts of last year. Of this amount, \$1,090.40 was received from the Winooski Aqueduct Company for water furnished to the village of Winooski. The unpaid bills for water, thirty-five in number, amount to \$234.31. There are now no places off for non-payment.

Pursuant to a resolution, recently passed by the Board of Aldermen, and approved by the Mayor, "That the Water Department is hereby directed to furnish to June 1st, 1905, water to the Winooski Aqueduct Company, at the same rate as is charged taxpayers of this city for like quantities of water," a temporary connection between the fire service of the Burlington Flouring Company and the mains of the Winooski Aqueduct Company, with opportunity for a two inch meter in the cellar of the flouring mill, has again been installed at the expense of the Winooski Aqueduct Company.

The indicated pumpage for the year, 360,312,725 gallons, is about 41,000,000 in excess of that of last year. About 11,000,000 of this increase was sold to the Winooski Aqueduct Company, and nearly the entire balance of the increase was, probably, due to waste, permitted to prevent freezing during the unusually cold winter of 1903-4. That

the trouble from frost was confined almost entirely to service pipes, was a matter of congratulation.

The stone post, mentioned in the recorded description of the Pumping Station premises, as marking the intersection of the north line of the right of way with the west line of Lake street, has not, as yet, been set.

No response to a resolution of your Honorable Board, calling upon the Central Vermont Railroad Company to vacate Lake street, or arrange to set apart other land acceptable to the city, in the lumber yard, has, so far as we are aware, been made. The water main in the north lumber yard lies along and under railroad track from Crane's office northerly for a distance of about two thousand feet.

Investigation of conditions as regards electrolysis of water mains, has been continued during the past season, under the direction of Professor W. H. Freedman, of the Electrical Engineering Department of the U. V. M.

No breaks or leaks have occurred during the past year which could be directly traced to electrolytic action, and at the times when observations were made, such change, from the conditions of former years, as was indicated, was in the direction of improved conditions, rather than otherwise.

Deposits to the sinking fund, to be applied in reduction of the bonded indebtedness of the Water Department, have been made during the past year to the amount of \$2,200.23,—\$40.25 in excess of the amount required by provision of the City Charter.

As shown by this and previous reports, deposits to this fund have been made to the amount of \$46,907.22. These deposits, with their increment, are included in the sinking fund in the custody of the City Treasurer. This fund, as appears by the report of the City Treasurer, amounts to \$105,678.41, of which \$83,000.00 is invested in city bonds.

The bonded debt of the city, incurred for this department, is made up as follows:

4 per cent. bonds, due in 1906.....	\$160,000 00
4 per cent. bonds, due in 1914.....	30,000 00
4 per cent. bonds, due in 1919.....	58,000 00
Total.....	\$248,000 00

Fifteen thousand of the issue due in 1906 are held by the sinking fund. There is no other outstanding indebtedness incurred for the Water Department.

The receipts from water rates for 1903, the amount provided for disbursement in 1904, have been sufficient to meet the current expenses of the Department, interest included, to pay \$2,800.00 for construction, and the balance, \$1,310.20, due on the Poor Farm extension, ordered by the City Council, and deposit to the sinking fund a small sum in excess of the five per cent. of the appropriation required by law.

Biological and chemical examinations have been made, as usual, at the Laboratory of the State Board of Health. For tabulated statement of these examinations, as also for other details of the season's work and expenditures, reference is made to the accompanying report of the Superintendent.

Respectfully submitted,

J. E. LANOU,	}	Water Commissioners.
JOHN J. FLYNN,		
THOS. F. CONLON,		

THIRTY-EIGHTH ANNUAL REPORT

OF THE

SUPERINTENDENT OF WATER WORKS.

To the Honorable Board of Water Commissioners of the City of Burlington, Vt.:

GENTLEMEN:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1904:

RECEIPTS.

From L. C. Grant, City Treasurer—	
Transfer to sinking fund required.....	\$ 2,159 98
Transfer to Poor Farm water supply required....	1,310 20
Transfer to construction required.....	2,800 00
Balance of appropriation for current expenses...	36,929 50
	Total amount of appropriation.....
	\$43,199 68
Amount received from material and labor.....	1,937 18
	Total receipts from City Treasurer.....
	\$45,136 86

DISBURSEMENTS.

Construction—

Labor on mains	\$ 837 96
Labor on services	312 01
Material for services	100 00
One fire hydrant	30 00
L. P. Wood, et al., six-inch, Cliff street.....	716 03
Isham Brothers, six-inch, Isham street.....	500 00
Queen City Cotton Co., four-inch, Wright avenue; one-inch, Conger avenue; one-inch, Harrison avenue	304 00
	Total construction
	\$ 2,800 00

WATER DEPARTMENT.

7

MAINTENANCE.

Current—

Pay rolls	\$ 3,932 39
Salary of Superintendent	1,500 00
Hydrant inspection and repairs	743 74
Stable expenses, including antitoxin and doctors' bills	679 78
Frozen services	595 14
Salary of Registrar	560 00
Material for management and repairs.....	520 13
Damages	433 12
Rent and sprinkling tax	404 62
Reservoir cleaning and repairs	384 54
Plumbers' bills	382 98
Tank cleaning and repairs	277 82
Printing, advertising and postage	182 90
Repair of tools	169 04
Office expenses	166 72
J. E. Lanou, Water Commissioner	100 00
J. J. Flynn, Water Commissioner	100 00
Telephone rent	77 08
T. F. Conlon, Water Commissioner	66 67
Electrolysis investigation	50 00
J. W. Goodell, Water Commissioner	33 33

\$11,360 00

Replacing cement pipe—

Pay rolls	\$5,189 05
Pipe	1,407 24
Lead and gates	749 49

\$7,345 78

\$18,705 78

INTEREST.

Interest on debt.....	\$ 9,920 00
-----------------------	-------------

PUMPING.

Low Service Station—

Pay rolls	\$ 2,937 61
Coal	2,694 03

CITY OF BURLINGTON.

Buildings and grounds	266 82
Oil and packing	132 53
Repairs to machinery	95 99
Lights	59 11
Repair of tools and supplies	36 20
	<hr/>
	\$6,222 29

High Service Station—

Building and grounds	\$138 82
Fuel and light	64 25
	<hr/>
	\$203 07

Steam pump—

Fuel	\$ 76 45
Repairs and care	55 71
	<hr/>
	\$132 16

Motor—

Repairs	\$153 02
Care	141 87
	<hr/>
	\$294 89
	<hr/>
	\$ 630 12
	<hr/>
	\$ 6,852 41

METERS.

Pay rolls	\$2,213 47
Meters	693 16
Material for repairs	441 61
	<hr/>
	\$ 3,348 24

Total maintenance\$38,826.43

TRANSFERS.

To sinking fund, 5% required by charter.....	\$ 2,159 98
To Poor Farm water supply by order of C. C....	1,310 20
Sinking fund, surplus funds	40 25
	<hr/>
Total transfers	\$ 3,510 43
	<hr/>
Total disbursements	\$45,136 86

RECAPITULATION.

RECEIPTS.

From L. C. Grant, City Treasurer.....\$45,136 86

WATER DEPARTMENT.

9

DISBURSEMENTS.

<i>Maintenance—</i>	
Current	\$18,705 78
Pumping	6,852 41
Meters	3,348 24
	<u>\$28,906 43</u>
Interest	9,920 00
	<u>Total maintenance</u>
	\$38,826 43
Transfers	3,510 43
Construction	2,800 00
	<u>Total disbursements</u>
	\$45,136 86

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates	\$ 7,262 77
Meter rates	37,836 83
	<u>Total receipts</u>
	\$45,099 60

DISBURSEMENTS.

L. C. Grant, City Treasurer.....	\$45,099 60
----------------------------------	-------------

UNPAID WATER RATES.

Meter rates, twenty-seven in number	\$ 209 11
Schedule rates, eight in number	25 20
	<u>Total unpaid water rates forward to 1905.....</u>
	\$ 234 31

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1904, of F. H. Crandall, Superintendent of the City Water Works, and find them correct.

We also find that the provision of the water ordinance, relative to collection of water rates, discount, penalty, etc., have been fairly and impartially administered.

W. H. ROBERTS,	} Auditors:
T. A. DELANY,	
A. L. DANIELS,	

**STATEMENT OF ASSESSMENTS AND CURRENT EXPENDITURES
FOR THE YEAR ENDING DEC. 31, 1904.**

The paid assessments of this statement are the receipts for the year, less whatever portion of the same was assessed previous to January 1, 1904. The unpaid are the unpaid of January 1, 1905, less whatever portion of the same are of more than one year's standing.

ASSESSMENTS.		DISBURSEMENTS.	
	<i>Paid.</i>		
Meter rates	\$37,698 06	Interest	\$ 9,920 00
Sched. rates	7,218 66	Current	\$18,705 78
	<u>\$44,916 72</u>	Pumping ...	6,852 41
Mat. and labor	1,937 18	Meters	3,348 24
	<u>\$46,853 90</u>		<u>\$28,906 43</u>
			\$38,826 43
	<i>Unpaid.</i>		
Meter rates	\$ 201 39	Excess of assessments	
Sched. rates	25 20	over disbursements	
Mat. & labor	24 97	for the year 1904..	\$ 3,279 03
	<u>\$ 251 56</u>		
	<u>\$47,105 46</u>		<u>\$47,105 46</u>

WATER PUMPED.

1904.	Gallons.
January	27,821,575
February	30,106,525
March	32,401,175
April	28,348,350
May	30,174,525
June	38,581,775
July	31,552,175
August	31,486,975
September	24,601,275
October	32,586,450

November	25,847,600
December	26,805,325
<hr/>	
Total 1904.....	360,312,725
Total 1903.....	319,463,200
<hr/>	
Increase in 1904.....	40,849,525
Daily average in 1904	987,158
Daily average in 1903	875,241

SERVICES.

There have been added 75 services of the following sizes:

Sixty-four	1½ inch.
Five	¾ inch.
Two	1 inch.
One	1½ inch.
Three	2 inch.

Five services were discontinued during the past season, Nos. 95 and 378 Main street; Nos. 85 and 91 Elmwood avenue, and No. 415 Maple street.

Of the seventy-five new services added during the season, four replace discontinued services and fifteen replace services found, owing to change of grade or other cause, to have less than six feet cover.

HYDRANTS.

A new public hydrant has been set on East avenue, and a private hydrant in the Pumping Station yard discontinued.

Three hydrant branches were found frozen during the extreme cold of last winter, and it was found necessary to replace three hydrants burst, by parties using same, for flooding skating rinks.

The use of public fire hydrants, particularly during cold weather, for any other than fire purposes, is a pernicious practice entailing, as it generally does, expensive repairs, besides the risk to adjacent property, incident to the disabling of hydrants.

Total number of public hydrants.....	179
Total number of private hydrants.....	37
<hr/>	
Total	216

SUPPLY PIPE.

	Feet.
One inch supply pipe in Harrison avenue, easterly from Conger avenue, was purchased of the Queen City Cotton Company, by order of the City Council, about.....	130
One inch supply pipe in Central avenue, extending southerly from Harrison avenue, was purchased of the Queen City Cotton Company, by order of the City Council, about.....	195
One and one-quarter inch supply pipe has been laid in Myrtle street, westerly from Champlain street.....	166
About 550 feet of 1¼ inch supply pipe has been removed from East avenue.	
Total length of supply pipe now in use.....	22,679

MAINS.

New mains have been laid as follows:

WITH FOUR INCH CAST IRON PIPE.

	Feet.
Bissell street, northerly from dead end.....	986

WITH SIX INCH CAST IRON PIPE.

On lake front at station	175
Total length of new mains.....	1,161

Cement, cast or wrought iron pipes have been replaced in the following streets:

WITH TEN INCH CAST IRON PIPE.

	Feet.
Howard street from St. Paul street, westerly.....	48
Howard street from South Willard street, westerly.....	515
Willard street from Main street to Maple street.....	827
Willard street from Howard street to Beech street.....	517

WITH EIGHT INCH CAST IRON PIPE.

Howard street, easterly from Pine street	1,235
Willard street, southerly from Main street.....	41

WITH SIX INCH CAST IRON PIPE.

Beech street, westerly from Willard street.....	305
Maple street, easterly from west line of Willard street.....	430
North avenue, southerly from North street.....	852

North Bend street, westerly from Rose street.....	365
North Champlain street, northerly from North street.....	393
North Champlain street, northerly from Poplar street.....	412
East avenue, southerly from Colchester avenue.....	730
Hayward street at Howard street	70
	<hr/>
	6,740

Four inch cast iron pipe has been removed as follows:

	Feet.
Hayward street at Howard street	70
East avenue near No. 64	180
South Willard street, from Maple street northerly.....	216

Six inch cast iron pipe has been removed as follows:

At Pumping Station	75
	<hr/>
Total pipe removed.....	541

LENGTH OF PIPE NOW IN USE.

Cement	23,589 feet.	About 5 miles.
Cast iron	186,694 feet.	About 35 miles.
	<hr/>	
Total	210,283 feet.	About 40 miles.

GATES.

The following gates have been discontinued:

Howard street west of St. Paul street.....	1	4	inch.
Howard street east of Union street.....	1	4	"
Howard street at Willard street	1	4	"
Willard street at Beech street	1	4	"
Maple street at Willard street	1	4	"
Willard street at Maple street	1	4	"
Willard street at Main street	1	4	"
North avenue near North street	1	4	"
Hayward street at Howard street.....	1	4	"
Champlain street at North Bend street	1	4	"
	<hr/>		
Total discontinued.....	10		

Gates have been set in the following locations:

Howard street at west line of Willard street.....	1	10	inch.
Willard street at south line of Howard street.....	1	10	"
Willard street at north line of Beech street.....	1	10	"

Willard street at north line of Maple street.....	1	10	"
Willard street at south line of Maple street.....	1	10	"
Willard street at south line of Main street.....	1	10	"
Howard street at east line of Hayward street.....	1	8	"
Howard street at west line of Hayward street.....	1	8	"
Howard street near No. 112	1	8	"
Hayward street at north line of Howard street.....	1	6	"
Hayward street at south line of Howard street.....	1	6	"
North avenue near No. 42	1	6	"
Beech street at west line of Willard street.....	1	6	"
Maple street at west line of Willard street.....	1	6	"
Maple street at east line of Willard street.....	1	6	"
Champlain street at south line of North Bend street.....	1	6	"
North Bend street at east line of Champlain street.....	1	6	"
North Bend street at west line of Champlain street.....	1	6	"
Willard street, south of Maple street main.....	1	4	"
Bissell street at south line of Canfield street.....	1	4	"
Bissell street at north line of Canfield street.....	1	4	"
East avenue near No. 94.....	1	4	"
Total added	22		
Total now in use	673		

SMALL STOP-GATES.

One small stop-gate was added in Myrtle street on west line of Champlain street, and one discontinued in Maple street west of Willard street.

Total number of small stop-gates now in use..... 66

REPAIRS.

The repairs for the year have been:

On cement pipe.....	5	bursts.
On cement pipe.....	1	leak.
On cement pipe.....	2	pick holes.
On iron pipe.....	1	burst.
On iron pipe.....	4	joint leaks.
On iron pipe.....	2	wooden plugs.
On services.....	30	leaks.
On services.....	128	frozen.
On hydrants.....	20	
On gates.....		

There were 259 services reported frozen last winter, and as the city does not undertake to remedy trouble on the premises of takers, probably many frozen services were not reported.

In 131 cases the trouble was found to be confined to the premises, and in many more it no doubt originated on the premises of the taker.

Ninety-three cases were successfully electrocuted; five were connected with nearby services; three were started with hot brine at the service box; one was dug out and lowered, and twenty-six remained frozen until opened by natural causes. Beside the services, there were two mains and three hydrant branches found frozen.

SINKING FUND.

Deposits to this fund have been made with the City Treasurer as follows:

Dec. 31, 1899, construction account for the year.....	\$2,726 42
Dec. 31, 1900, construction account for the year.....	2,200 00
Dec. 31, 1901, construction account for the year.....	6,421 50
Dec. 31, 1902, construction account for the year.....	1,174 17
Dec. 31, 1903, to apply on North avenue extension account..	2,985 74
Feb. 3, 1904, balance of North avenue extension account..	1,310 20

To be applied in reduction of the bonded debt:

Sept. 10, 1897, 5 per cent. required by charter.....	\$2,360 25
Aug. 4, 1898, 5 per cent. required by charter.....	2,259 16
Aug. 10, 1899, 5 per cent. required by charter.....	2,297 94
Aug. 14, 1900, 5 per cent. required by charter.....	2,439 13
Aug. 8, 1901, 5 per cent. required by charter.....	2,454 67
Aug. 7, 1902, 5 per cent. required by charter.....	2,391 58
Aug. 5, 1903, 5 per cent. required by charter.....	2,140 87
Aug. 4, 1904, 5 per cent. required by charter.....	2,159 98
Nov. 9, 1899, surplus funds.....	4,000 00
Dec. 31, 1899, surplus funds.....	1,531 17
Dec. 31, 1900, surplus funds.....	9,857 45
Dec. 31, 1901, surplus funds.....	5,210 97
Dec. 31, 1902, surplus funds.....	6,894 49
Dec. 31, 1903, surplus funds.....	869 31
Dec. 31, 1904, surplus funds.....	40 25

Total\$46,907 22

HIGH SERVICE.

The consumption on the high service, as indicated by the pumping record of that station, was about fourteen million gallons, or about 4 per cent of that of the low service. Of this amount, about 92 per cent. was measured to consumers through meters; 5 per cent. was the estimated loss in the motor, and about 3 per cent. remains unaccounted for.

About 72 per cent. of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 28 per cent. by the auxiliary steam pump.

METERS.

There are now in use 2,770 meters, an increase of 90 over last year.

Of the water pumped, about 57 per cent. has passed through meters yielding about 84 per cent. of the revenue.

Respectfully submitted,

F. H. CRANDALL,

Superintendent.

BURLINGTON, Vt., Dec. 30th, 1904.

Mr. F. H. Crandall, Supt. Burlington City Water Works:

DEAR SIR:—Having continued making observations, from time to time, on the electrical conditions existing in this city bearing upon the electrolytic corrosion of the water mains, I take pleasure in reporting as follows:

Table I gives the average voltage between the rails and the hydrants in that section of the city where the action is apt to be the greatest. The readings cover the years 1896, 1901, 1902, 1903 and 1904. These results are also shown graphically in the accompanying voltage chart, in which the vertical distances represent volts and the horizontal distances represent the actual distances of the hydrants from the power station.

The average current in amperes flowing in the mains was determined by inserting instruments in the pipe lines at the times of temporary interruption, or at the location of the cement sleeve on

Colchester avenue on the hill opposite Green Mount cemetery. These results are given in Table II.

The voltage and the current readings show that the situation, as a whole, is improved, and that the rate at which corrosion is taking place is probably decreased. This is most likely caused by the installation of the storage battery equipment and metallic feeder connection from storage battery at car barn to power station, as the decrease of the readings dates from this addition by the Traction Company.

Measurements of the electrical resistances between the hydrants and the rails indicate that this resistance is less than it should be, with the lowest value at the hydrant near Colchester avenue and East avenue, as given in Table III. I would, therefore, recommend that this spot in particular be closely watched, and that the system, as a whole, be treated as follows:

First—All connections between rails and pipes, whenever discovered, be removed.

Second—The piping system be separated from the rails by as great a distance as possible.

Respectfully submitted,

W. H. FREEDMAN.

TABLE I.

No. and Location of Hydrant.	Date.	Maximum.	Minimum.	Average.	No. of Readings.	Period Covered.	Time of Day.	Remarks.
No. 1. Colchester Ave. and Barrett St. No. 1 Hydrant is nearest to Power House.	July 30, '01	+ 3.0		+1.8		10 min. approx.		Always +, ave. estimated.
	July 31, '01	+ 4.3		+1.0		"		" " "
	Aug. 24, '01	+ 4.0	+1.5 +2.5			"		" " "
	Aug. 28, '06	+ 8.5	+1.8 +4.0		21	5 min.	2.20 P. M.	Always +.
	Apr. 18, '02	+ 4.2	+1.0 +2.6			5 "	3.00 P. M.	" "
	Jan. 22, '03	+15.0	+2.0 +6.26		121	20 "	4.30 P. M.	" "
	Mar. 13, '04	+16.0	+6.29		601	60 "	1.30 P. M.	+ and -.
	June 18, '04	+ 1.7	+ .0083		180	30 "	2.30 P. M.	" " "
	Nov. 28, '04	+ 6.3	-2.8 + .0094		175	29 "		
No. 2. Barrett and Chase Sts.	July 30, '01	+ 2.0	+1.4			10 min. approx.		Always +, ave. estimated.
	July 31, '01	+ 1.8	+0.9			"		" " "
	Aug. 24, '01	+ 2.9	+0.5 +1.5			"		" " "
	Aug. 28, '06	+ 4.0	+1.0 +2.5		21	5 min.	2.30 P. M.	Always +.
	Apr. 18, '02	+ 2.5	+0.1 +1.0			5 "	3.40 P. M.	" "
	Jan. 22, '03	+10.3	+1.3 +5.21		121	20 "	4.30 P. M.	" "
	Mar. 14, '03	+11.0	+4.6		601	60 "	2.20 P. M.	+ and -.
	June 18, '04	- 1.1	+ .0053		176	30 "		" " "
	Dec. 8, '04	+ 5.0	-2.8 + .0106		180	30 "	11.39 A. M.	

TABLE I—Continued.

No. and Location of Hydrant.	Date.	Maximum.	Minimum.	Average.	No. of Readings.	Period Covered.	Time of Day.	Remarks.
No. 3. Colchester Ave. and Chase St.	July 30, '01	+ 2.0		+1.4		10 min. approx.		Minus for an instant, ave. est.
	July 31, '01	+ 3.4		+1.6		"		Always +, ave. estimated.
	Aug. 24, '01	+ 3.6	+1.2	+2.0		"		" " " "
	Aug. 28, '06	+ 3.2	+0.6	+1.7	21	5 min.	2.47 P. M.	Always +.
	Apr. 18, '02	+ 3.0	+0.3	+1.25	121	5 "	4.20 P. M.	" "
	Jan. 22, '03	+10.6	+1.1	+4.98	601	20 "	4.30 P. M.	" "
	Mar. 14, '03	+ 4.83		+3.5	176	30 "	3.10 P. M.	+ and -.
	June 18, '04	- 1.6		+ .06	180	30 "	2.45 P. M.	+ and -.
	Dec. 6, '04	+ 4.5	-2.5	1.88				
	July 30, '01	+ 3.8		+3.0		10 min. approx.		Always +, ave. estimated.
No. 4. Colchester Ave. at Top of Hill.	July 31, '01	+ 4.3		+2.5		"		" " " "
	Aug. 24, '01	+ 3.8	+0.4	+1.5		"		" " " "
	Aug. 28, '06	+ 3.0		+1.5		5 min.		Minus occasionally.
	Apr. 18, '02	+ 5.5	-5.0	+2.23	21	5 "	3.00 P. M.	Always +, excepting twice.
	Jan. 22, '03	+ 8.0	+0.1	+3.7	121	20 "	5.00 P. M.	Always +.
	Mar. 14, '03	+ 5.7		+1.42	601	60 "	4.30 P. M.	" "
	June 18, '04	+ 2.3		+2.66	175	30 "	4.00 P. M.	+ and -.
	Nov. 29, '04	+ 4.1	-4.4	+1.54	190	32 "	1.55 P. M.	+ and -.

TABLE I—Continued.

No. and Location of Hydrants.	Date.	Maximum.	Minimum.	Average.	No. of Readings.	Period Covered.	Time of Day.	Remarks.
No. 5. Colchester Ave. and East Ave.	July 30, '01	+ 1.8		+ 0.9		About 10 min.		— an instant, ave. estimated.
	July 31, '01	+ 3.8		+ 1.8		" " "		Always +, ave. estimated.
	Aug. 24, '01	+ 3.5	+ 1.0	+ 1.6		" " "		" " "
	Aug. 28, '06	+ 2.3	— 0.5	+ 0.75		5 min.		" " "
	Apr. 18, '02	+ 4.0	+ 0.2	+ 2.0	21	5 "	3.13 P. M.	Always +.
	Jan. 26, '03	+ 10.0	+ 1.0				12.00 M.	Minus once.
	June 18, '04	— 3.2	— 0.5	+ 0.37	121	20 "	4.45 P. M.	+ and —.
No. 6. Colchester Ave. at Ira Allen School.	Nov. 22, '04	+ 4.7	+ 2.1	+ .271	180	30 "	2.38 P. M.	+ and —.
	July 30, '01	+ 3.2		+ 1.9		10 min. approx.		Always +, ave. estimated.
	July 31, '01	+ 4.3		+ 2.2		" " "		Minus once, ave. estimated.
	Aug. 24, '01	+ 3.5	+ 0.1	+ 1.8		" " "		Always +, ave. estimated.
	Aug. 26, '06	+ 2.5	— 0.3	+ 0.8		14 min.		
	Apr. 18, '02	+ 4.1	— 3.0	+ 0.92	21	5 "	3.24 P. M.	5 Minus Readings.
	Jan. 26, '03	+ 7.8	+ 0.2	+ 3.11	121	20 "	4.00 P. M.	1 Minus Reading.
	Mar. 14, '03	+ 11.8		+ 4.21	601	60 "	3.00 P. M.	
	June 18, '04	+ 2.6		+ 0.46	172	30 "	5.30 P. M.	+ and —.
	Nov. 22, '04	+ 8.7	— 2.2	+ 1.93	180	30 "	11.23 A. M.	+ and —.

TABLE I—Continued.

No. and Location of Hydrant.	Date.	Maximum.	Minimum.	Average.	No. of Readings.	Period Covered.	Time of day.	Remarks.
No. 7. Colchester Ave. at bend of road.	July 30, '01	+ 2.9		+ 1.6		10 min. approx.		Minus once, ave. estimated.
	July 31, '01	+ 3.3		+ 0.7		"		Always +, ave. estimated.
	Aug. 24, '01	+ 3.0	+ 0.4	+ 1.5	22	"	3.40 P. M.	"
	Apr. 18, '02	+ 3.8	- 0.5	+ 1.9	122	5 min.	4.38 P. M.	Minus once.
	Jan. 26, '03	+ 7.1	- 2.0	+ 2.62	601	20 "	3.00 P. M.	
	Mar. 14, '03	+ 5.9		+ 3.00	176	60 "	2.15 P. M.	
	June 23, '04	+ 1.2		+ .013	30	31 "	2.55 P. M.	
	Nov. 19, '04	+ 4.1	- 1.4	+ .833	189			
No. 8. Colchester Ave. and Mansfield Ave.	July 30, '01	+ 4.5		+ 2.3		10 min. approx.		Always +, ave. estimated.
	July 31, '01	+ 1.8		+ 1.2		"		"
	Aug. 24, '01	+ 2.8	+ 0.3	+ 1.0	21	"	3.50 P. M.	"
	Apr. 18, '02	+ 4.1	+ 0.1	+ 1.86	121	5 min.	9.20 A. M.	Always +.
	Jan. 27, '03	+ 4.9	- 3.2	+ 1.6	601	20 "	3.00 P. M.	Minus for 3 min. car passing.
	Mar. 14, '03	+ 13.0		+ 4.5	173	60 "	3.15 P. M.	+ and -.
	June 23, '04	- 1.8		+ .005	30	30 "	9.05 A. M.	14 neg. readings.
	Dec. 15, '04	+ 13.6	- 0.9	+ 3.15	180			

TABLE I—Continued.

No. and Location of Hydrants.	Date.	Maximum.	Minimum.	Average.	No. of Readings.	Period Covered.	Time of Day.	Remarks.
No. 9. Pearl and Prospect Sts.	July 30, '01	+ 3.0		+ 2.0		10 min. approx		Minus as car passed.
	July 31, '01	+ 2.8		+ 0.7		"		Minus occasionally.
	Aug. 24, '01	+ 2.3	- 1.0	+ 1.0	21	5 min.	2.26 P. M.	Minus for an instant.
	Aug. 25, '02	+ 2.2	- 2.0	+ 0.31	121	20 "	10.20 A. M.	7 Minus Readings.
	Jan. 27, '03	+ 3.5	- 2.3	+ 1.22	601	60 "	3.00 P. M.	- nearly 5 min. when c. pass.
	Mar. 14, '03	+ 14.43		+ 4.02	149	30 "	4.55 P. M.	+ and -.
	June 23, '04	+ 2.2	+ 0.12	+ 0.12	169	30 "	2.38 P. M.	+ and -.
	Dec. 8, '04	+ 5.3	- 0.7	+ 1.23	169	30 "		Neg. for 5 min.
	July 30, '01	+ 1.0		+ 0.5		10 min. approx.		Minus occasionally.
	July 31, '01	+ 3.2		+ 0.9		"		Always +.
No. 10. Pearl and Willard Sts.	Aug. 24, '01	+ 1.8	+ 0.4	+ 1.1	21	5 min.	2.40 P. M.	Always +.
	Aug. 25, '02	+ 2.6	- 0.2	+ 0.96	121	20 "	11.20 A. M.	3 Minus Readings.
	Jan. 27, '03	+ 1.8	- 5.4	- 0.54	601	60 "	2.30 P. M.	Nearly always +. 3 sets + & -.
	Mar. 16, '03	+ 4.5	- 2.6	+ 0.9	601	60 "	4.55 P. M.	+ and - variable.
	June 23, '04	+ 5.1	+ 0.96	+ 0.96	173	30 "	2.50 P. M.	+ and -.
	Dec. 8, '04	+ 7.2	- 2.9	+ 1.84	180	30 "		+ and -.

TABLE I—Concluded.

No. and Location of Hydrants.	Date.	Maximum.	Minimum.	Average.	No. of Readings.	Period Covered.	Time of Day.	Remarks.
No. 11. Pearl and Union Ste.	July 30, '01	1.4	+	1.0		10 min. approx.		Always +.
	July 31, '01	1.6	+	0.4		"		Often —.
	Aug. 24, '01	1.0	—0.8	+ 0.5		"		Variable.
	Apr. 25, '02	1.9	—0.3	+ 0.42	21	5 min.	2.52 P. M.	3 Minus Readings.
	Jan. 27, '03	6.0	+0.3	+ 2.08	121	20 "	12.30 P. M.	2 Plus Readings.
	Mar. 16, '03	9.0	—5.0	—0.57	601	60 "	2.30 P. M.	
	June 24, '04	2.0	—	+ 0.6	175	30 "	4.10 P. M.	5 Minus Readings.
	Dec. 8, '04	8.8	—2.8	+ 1.84	180	30 "	3.36 P. M.	+ and —.

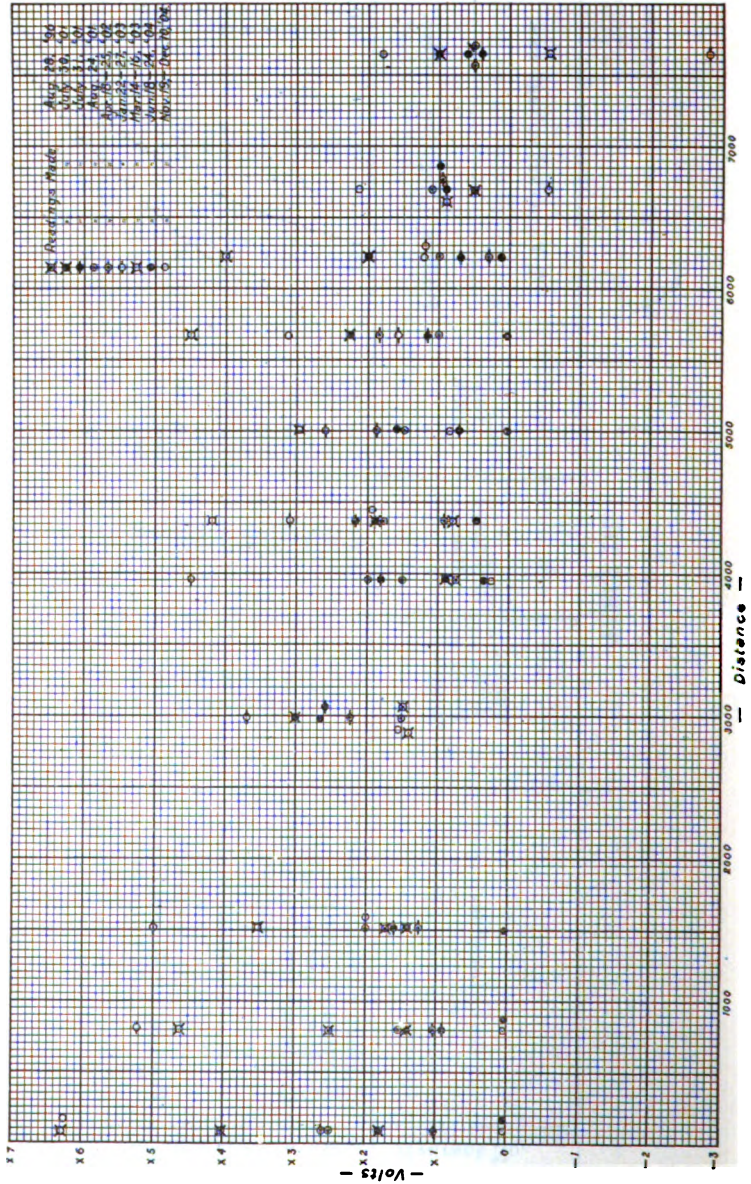
TABLE II.

No.	Location.	Date.	Average Amperes.		Period of Observations.	Remarks.
			+	-		
1	Colchester Ave. and Barrett St.	Aug. 24, '01	1.75		10 min.	Current always toward Power Station or Plus.
2	So. Union St. and Maple St.	Oct. 24, '01	0.5		10 min.	" " " " " "
3	Col. Ave. top of hill near Cem.	Sept. 10, '03	3.0		20 min.	" " " " " "
4	Colchester Ave., opp. Cemetery.	Sept. 30, '03	1.9		20 min.	" " " " " "
5	" " " "	May 26, '04	0.82	0.9	20 min.	Current very variable, Sometimes +, Sometimes -.
6	" " " "	June 4, '04	0.7	0.6	30 min.	" " " " " "
7	" " " "	Dec. 21, '04	0.25		32 min.	Current always toward Power Station or Plus.
8	" " " "	Dec. 22, '04	0.2		57 min.	" " " " " "

TABLE III.

Hydrant No.	Location.	Distance from Power Station.	Resistance Ohms.	Date 1904.	% Time that voltage was.		
					Positive.	Negative.	Zero.
1	Colchester Ave. and Barrett St.	89'	1.119	Nov. 29,	42.5	52.5	5.0
2	Barrett and Chase Sts.	810'	1.163	Dec. 8	45.2	53.1	1.7
3	Colchester Ave. at Chase St.	1520'	.582	Dec. 6	77.8	20.0	2.2
4	Colchester Ave. (Top of Hill).	2995'	.5945	Nov. 29	56.3	41.6	2.1
5	" (At East Ave.)	3958'	.385	Nov. 22	50.3	45.1	4.6
6	" (At Ira Allen School).	4382'	.445	Nov. 22	81.4	15.3	3.3
7	" (At bend of road).	5019'	.595	Nov. 19	76.3	20.4	3.3
8	" (At Mansfield Ave.)	5670'	.488	Dec. 16	89.5	9.2	1.3
9	" (At Prospect St.)	6222'	.732	Dec. 8	85.2	13.0	1.8
10	Pearl St. (at Willard St.)	6798'	.647	Dec. 9	92.9	3.9	3.2
11	" (At Union St.)	7654'	.570	Dec. 8	88.3	9.2	2.5

- VOLTAGE - CHART -



WATER DEPARTMENT.

27

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.

Number	Collected	Examined	Turbidity	Sediment	Color	Odor		Parts in 1,000,000								
								Residue			Ammonia		Chlorine	Hardness	Nitrogen as Nitrates	Nitrogen as Nitrites
								Total solids	Loss on Ignition	Fixed Solids	Free	Albu- minoid				
26328	1-6-04	1-6-04	Distinct	Very slight	15 None	None	80.0	19.0	41.0	.008	.108	1.8	53.9	290	.000	
26319	1-13-04	1-13-04	Slight	"	18 Ft. aromatic	Ft. aromatic	73.5	16.5	57.0	.002	.136	1.3	54.3	310	.000	
26486	1-20-04	1-20-04	Distinct	"	20 Very ft. veg.	Very ft. veg.	69.0	7.0	63.0	.006	.106	1.3	61.4	300	.000	
26578	1-27-04	1-27-04	Distinct	"	27 Faint veget.	Faint veget.	54.0	8.0	48.0	.008	.104	1.2	49.0	200	.000	
26703	2-8-04	2-8-04	Slight	"	12 None	None	68.0	17.0	51.0	.019	.106	1.1	51.0	280	.000	
26839	2-10-04	2-10-04	Very slight	"	14 Very ft. veg.	Very ft. veg.	68.0	18.0	54.0	.004	.104	1.1	52.9	310	.000	
26867	2-17-04	2-17-04	Slight	"	20 Faint veget.	Faint veget.	79.0	22.0	57.0	.006	.106	.9	54.3	200	.000	
26319	2-24-04	2-24-04	"	"	18 None	None	71.0	14.0	57.0	.004	.100	1.0	55.7	290	.000	
26326	2-2-04	2-2-04	"	"	20 Faint veget.	Faint veget.	71.0	14.0	57.0	.014	.118	1.3	58.6	280	.000	
26326	2-9-04	2-9-04	Distinct	"	20 Very ft. veg.	Very ft. veg.	68.0	17.0	51.0	.004	.104	1.2	53.9	300	.000	
26451	2-16-04	2-16-04	Slight	"	26 " "	" "	68.0	16.0	50.0	.010	.100	1.1	52.0	260	.000	
26676	2-23-04	2-23-04	"	"	26 " "	" "	68.0	11.5	48.0	.004	.104	1.3	56.7	290	.000	
26676	2-29-04	2-29-04	Distinct	"	22 Dist. aromatic	Dist. aromatic	64.0	18.0	46.0	.008	.104	1.1	50.0	200	.000	
26676	4-6-04	4-6-04	Distinct	"	15 Ft. aromatic	Ft. aromatic	70.0	17.0	53.0	.018	.112	1.1	60.0	200	.000	
26687	4-13-04	4-13-04	"	"	23 Very ft. veg.	Very ft. veg.	60.0	20.0	40.0	.006	.116	1.1	44.0	280	.000	
26680	4-20-04	4-20-04	Slight	"	15 Ft. aromatic	Ft. aromatic	64.0	14.5	49.5	.010	.108	1.2	52.9	200	.000	
27072	4-27-04	4-27-04	Distinct	"	8 Very ft. veg.	Very ft. veg.	62.5	17.5	45.0	.020	.122	1.1	50.0	210	.000	
27202	5-4-04	5-4-04	Very Slight	"	18 Dist. veg.	Dist. veg.	68.0	20.0	48.0	.016	.136	1.1	52.9	310	.000	
27287	5-11-04	5-11-04	Distinct	"	15 None	None	73.0	22.0	50.0	.008	.130	1.1	55.7	210	.000	
27448	5-18-04	5-18-04	"	"	15 Very ft. veg.	Very ft. veg.	72.0	27.0	45.0	.026	.108	1.1	54.3	200	.000	
27544	5-25-04	5-25-04	"	Slight	14 Decid. aromatic	Decid. aromatic	66.0	24.0	41.0	.013	.136	1.1	54.3	110	.000	
27388	6-15-04	6-15-04	"	Very slight	17 D. earthy dc	D. earthy dc	65.0	24.0	41.0	.012	.144	1.0	49.0	170	.000	
28017	6-22-04	6-22-04	"	"	20 Dec. aromatic	Dec. aromatic	66.5	17.0	49.5	.016	.180	1.0	51.0	100	.000	

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.
Continued.

Source	Bacteria		Microscopically	Remarks
	Bacteria In one c. c.	B. Coll B. Coll per c. c.		
Tap at Laboratory	600 Ab't		Negative.....	Biologically and chemically is a good quality
"	"		Amorphous matter.....	Chem. is unobject; biol. shows the pres. of the
"	1600 Pres.		Negative.....	bacillus coli communis (sew. bact.).....
"	100 Ab't		"	Biologically and chemically is a good quality
"	800 "		Small amount of amorphous matter.....	"
"	1000 "		Negative.....	"
"	800 "		"	"
"	6300 "		"	"
"	800 Pres.		"	Biol. the no. of bact. is high; chem. is unobj't.
"	"		"	Chem. is unobject; biol. shows the pres. of the
"	900 "		"	bacillus coli communis (sew. bact.).....
"	100 Ab't		"	Chem. is unobject; biol. shows the pres. of the
"	1000 "		"	bacillus coli communis (sew. bact.).....
"	3000 "		"	Biologically and chemically is a good quality
"	1000 "		"	"
"	1100 "		Amorphous matter.....	"
"	"		Negative.....	Biol. the no. of bact. is high; chem. is unobj't.
"	100 Pres.		"	Biologically and chemically is a good quality
"	600 Ab't		"	Chem. is unobject; biol. shows the pres. of the
"	2100 "		"	bacillus coli communis (sew. bact.).....
"	"		"	Biologically and chemically is a good quality
"	"		"	"
"	4500 "		"	Biol. the no. of bact. is high; chemically is
"	800 "		"	unobject.....
"	800 "		"	Biologically and chem. is unobjectable.....
"	"		"	Biologically and chemically is a good quality
"	"		"	Chem. is unobject; biol. shows the pres. of
"	"		"	the bacillus coli communis (sew. bact.).....
"	800 Pres.		"	Biologically and chemically is a good quality
"	300 Ab't		"	"

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.
continued.

Number	Collected	Examined	Turbidity	Sediment	Odor		Parts in 1,000,000						Hardness	Nitrogen as Nitrates	Nitrogen as Nitrites
					Color	Hot	Total Solids	Loss on Ignition	Fixed Solids	Ammonia		Chlorine			
										Free	Albuminoid				
28152	6-29-04	6-29-04	Distinct	Slight	25 V. ft. ar. ft.	25 V. ft. ar. ft.	V. ft. ar. ft.	65.0	32.0	43.0	.008	1.0	51.0	.150	.000
28331	7-6-04	7-6-04	Slight	Very slight	15 Dist. veg.	15 Dist. veg.	Dist. veg.	65.0	35.5	39.5	.014	1.1	61.4	.160	.000
28351	7-13-04	7-13-04	Slight	Slight	13 Faint veget.	13 Faint veget.	Faint veget.	63.5	37.0	36.5	.005	.8	53.6	.160	.000
28451	7-20-04	7-20-04	Distinct	Very slight	8 " "	8 " "	" "	63.0	36.0	43.0	.008	1.0	53.6	.160	.000
28554	7-27-04	7-27-04	"	Slight	26 " "	26 " "	" "	67.0	19.0	46.0	.014	.9	60.0	.160	.000
28577	8-3-04	8-3-04	"	"	25 D's't arom'c	25 D's't arom'c	D's't arom'c	73.0	17.0	55.0	.014	.9	51.4	.160	.000
28739	8-10-04	8-10-04	"	"	13 Faint veget.	13 Faint veget.	Faint veget.	68.0	16.0	52.0	.012	1.1	57.1	.130	.000
28935	8-17-04	8-17-04	Slight	Very slight	21 F't aromatic	21 F't aromatic	F't aromatic	69.0	19.0	50.0	.006	1.0	57.1	.150	.000
29048	8-24-04	8-24-04	Slight	Slight	10 V. ft. veget.	10 V. ft. veget.	Faint veget.	66.0	17.0	49.0	.013	.9	57.1	.150	.000
29168	8-31-04	8-31-04	Distinct	Very slight	26 None	26 None	None	65.0	17.0	46.0	.018	1.1	51.4	.170	.000
29261	9-7-04	9-7-04	Slight	Slight	19 Faint	19 Faint	Faint	65.0	19.0	46.0	.006	.9	55.7	.130	.000
29453	9-14-04	9-14-04	Slight	Slight	10 V. ft. veget.	10 V. ft. veget.	V. ft. veget.	70.0	23.0	46.0	.004	1.0	61.4	.200	.000
29459	9-21-04	9-21-04	Distinct	Very slight	27 " "	27 " "	" "	70.0	30.0	50.0	.010	.9	54.8	.100	.000
29678	9-28-04	9-28-04	Slight	Slight	16 None	16 None	None	70.0	30.0	50.0	.014	1.0	60.0	.200	.000
29804	10-5-04	10-5-04	Slight	"	15 Faint veget.	15 Faint veget.	Faint veget.	64.0	17.0	47.0	.006	.114	57.1	.200	.000
29967	10-12-04	10-12-04	Slight	"	8 D's't arom'c	8 D's't arom'c	D's't arom'c	71.0	16.0	55.0	.013	1.1	55.0	.180	.000
29990	10-19-04	10-19-04	Distinct	Very slight	13 None	13 None	None	69.5	19.5	50.0	.006	1.1	53.0	.200	.000
30128	10-26-04	10-26-04	Slight	"	10 D's't arom'c	10 D's't arom'c	D's't arom'c	71.5	14.5	57.0	.006	.9	55.7	.140	.000
30250	11-2-04	11-2-04	Distinct	"	15 Faint	15 Faint	Faint	66.0	17.0	49.0	.003	.9	48.0	.180	.000
30364	11-9-04	11-9-04	"	Very slight	19 V. ft. earthy	19 V. ft. earthy	V. ft. earthy	65.0	10.5	54.5	.004	.9	55.7	.210	.000
30491	11-16-04	11-16-04	"	"	26 F't. earthy	26 F't. earthy	F't. earthy	71.0	13.0	59.0	.006	.9	53.9	.160	.000
30715	11-23-04	11-23-04	Slight	"	14 None	14 None	None	65.0	11.0	54.0	.012	1.1	53.0	.180	.000
30715	11-30-04	11-30-04	"	"	16 " "	16 " "	" "	66.0	23.0	43.0	.004	1.0	47.0	.210	.000
30845	12-7-04	12-7-04	Distinct	"	15 V. ft. veget.	15 V. ft. veget.	V. ft. veget.	59.5	11.5	48.0	.006	1.1	53.9	.180	.000
30970	12-14-04	12-14-04	Slight	"	15 " "	15 " "	" "	73.0	19.0	54.0	.006	1.1	53.9	.280	.000
31055	12-21-04	12-21-04	Dist.	"	14 Faint veget.	14 Faint veget.	" "	78.0	18.0	60.0	.002	1.2	57.1	.310	.000
31185	12-28-04	12-28-04	"	"											

ANALYSIS OF CITY WATER MADE EACH WEEK AT THE LABORATORY OF THE STATE BOARD OF HEALTH.
continued.

Source	Bacteria		Microscopically	Remarks
	Bacteria In one c. c.	B. Coll per c. c.		
Tap at Laboratory	400 Pres.		Small amount amorphous matter.	Chem. shows its usual cond.: biol. shows the
"	1100 Ab't.		Negative	pres. of sewage contamination.
"	100 "		"	Biol. the no. of bact. is high: chem. is unob.
"	2400 "		Small amount amorphous matter.	Biologically and chemically is a good quality
"	400 "		Negative	"
"	400 "		"	"
"	150 Pres.		"	Biol. and chem. the pres. sample is unob.
"	540 Ab't.		"	Normal.
"	450 "		"	This sample shows water safe at pres. time.
"	200 "		"	Safe at present time.
"	100 "		Many diatoms, synedra, asterionella, etc.	Normal: safe at present time.
"	80 "		Algae and diatoms.	Safe at present.
"	50 Pres.		Negative	Suspicious
"	490 Ab't.		"	Normal
"	80 "		"	Normal condition.
"	80 "		"	"
"	600 Pres.		"	Shows pres. of the colon bacillus.
"	180 Ab't.		Few diatoms (asterionella and synedra).	Normal condition. Diatoms commencing to
"	850 "		" " " "	appear in large numbers.
"	170 Pres.		Negative.	Shows the increase in algae noted in last
"	130 "		"	specimen, otherwise normal.
"	140 Ab't.		"	Shows presence of colon bacilli.
"	130 "		"	Shows pres. of sew. bact: otherwise normal.
"	70 "		Small amount of amorphous matter.	Shows pres. of sewage bacteria.
"	100 Pres.		Negative.	Normal condition.
"			"	"

*Impossible to count.

1904.

SUMMARY OF STATISTICS

SUGGESTED BY THE

New England Water Works Association.

Burlington City Water Works.
Burlington, Chittenden County, Vermont.
Population by U. S. census, 1900, 18,640.
Works constructed 1867-8.
Owned by city.
Source of supply, Lake Champlain.
Mode of supply, pumping.

PUMPING.

1. Builders of pumping machinery, H. R. Worthington.
2. Description *b* Bituminous.
 d Nonpareil and Clearfield.
of fuel. *e* \$4.10 and \$3.46½.
6. Total pumpage for the year, 360,312,725 gallons.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
Cost of pumping, figured on Pumping Station expenses, viz.:
 \$6,852.41.
11. Per million gallons raised against dynamic head into reservoir,
 \$19.04.
12. Per million gallons raised one foot high (dynamic), \$.07.
Cost of pumping, figured on total maintenance, viz.: \$38,826.43.
13. Per million gallons raised against dynamic head into reservoir,
 \$107.85.
14. Per million gallons raised one foot high (dynamic), \$.37.

FINANCIAL.

MAINTENANCE.

Division I.

RECEIPTS.

From consumers :	
A. Water rates, domestic....	\$35,480.13
B. Water rates, mfg.....	2,880.68
C. Net receipts for water....	\$38,310.76
D. Miscellaneous.....	1,987.18
E. Total.....	\$40,247.94
From public funds:	
F. Hydrants	\$3,500.00
G.* Fount. and parks	346.65
H.* Street watering..	2,068.30
I.* Public buildings..	507.48
Water troughs...	237.50
Other public use.	88.91
	6,788.84
K. Gross receipts from all sources.....	\$47,086.78

*Paid at meter rates.

EXPENDITURES.

AA. Management and repairs:	
Current.....	\$18,706.78
Pumping.....	6,852.41
Meters.....	3,248.24
	\$28,806.43
BB. Interest on bonds.....	9,920.00
CC. Total maintenance.....	\$38,826.43
DD. Balance	8,210.35
Total.....	\$47,086.78

Division II.

From fixed rates—

L. Domestic	\$ 7,262 77
M. Manufacturing	
N.	\$ 7,262 77

From meter rates—

O. Domestic	\$34,956 20
P. Manufacturing	2,880 63
Q.	\$37,836 83
Total.....	\$45,099 60

CONSTRUCTION.

RECEIPTS.

T. Trans. from Current Appropriation	\$2,800 00
V. Total	\$2,800 00

DISBURSEMENTS.

FF. Extension of mains.	\$2,387 99
GG. Extension of services	412 01
KK. Total	\$2,800 00

W. Cost of works to date	\$483,600 65
X. Bonded debt at date	248,000 00
Y. Value of sinking fund at this date, about.....	53,000 00
Z. Rate of interest, 4 per cent.	

CONSUMPTION.

1. Estimated total population at date, 19,700.
2. Estimated total population on lines of pipe, 19,200.
3. Estimated total population supplied, 19,100.
4. Total number of gallons consumed for year, 360,312,725.
5. Passed through domestic meters, 188,947,237 gallons, or 52 per cent.
6. Passed through manufacturing meters, 16,988,250 gallons, or 5 per cent.
7. Average daily consumption, 987,158 gallons.
8. Gallons per day to each inhabitant, 50.
9. Gallons per day to each consumer, 51.
10. Gallons per day to each tap, 270.

DISTRIBUTION.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Galvanized iron, cast iron and lead.
2. Size from 4 to 30 inches.	17. From $\frac{1}{2}$ to 6 inches.
3. Extended, 7,901 feet.	18. 1,903 feet.
4. Discontinued, 6,740 feet.	19. 500 feet.
5. Total now in use, about 40 miles.	20. 19.5 miles, or 102,298 feet.
6. Cost of repairs per mile, \$9.53.	21. Service taps added, 56.
7. Leaks per mile, .22.	22. Number now in use, 3,580.
8. Small distribution pipe less than 4 inch, total length 22,679 feet.	23. Average length of services, 25 feet.
9. Hydrants added, 1.	24. Average cost of services, \$8.31.
10. Number now in use, 216.	25. Meters added, 90.
11. Stop-gates added, 22.	26. Meters now in use:
12. Number now in use, 673.	a. domestic, 2,730
13. Small stop-gates less than 4 inch, total 66.	b. manufacturing, 40
14. Number of blow-off gates, 14.	Total, 2,770
15. Range of pressure on mains at center, for day and night, 70 to 85 pounds.	27. Motors and elevators added 0.
	28. Number now in use, 35.

STORAGE.

Earthwork reservoirs, low service, capacity 7,000,000 gallons; iron tank, high service, capacity 169,617 gallons.

BOSTON SOCIETY
OF
ENGINEERS

Thirty-Ninth Annual Report

OF THE

Water Department

OF THE

City of Burlington, Vermont

AND OF THE

WATER COMMISSIONERS

The Seventeenth

December 31, 1905

Thirty-Ninth Annual Report

OF THE

Water Department

OF THE

City of Burlington, Vermont

AND OF THE

WATER COMMISSIONERS

The Seventeenth

December 31, 1905

BURLINGTON:
FREE PRESS PRINTING CO.,
PRINTERS, BINDERS, STATIONERS.
1906.

Board of Water Commissioners

T. F. CONLON, Chairman, (Term expires 1907).

J. E. LANOU, (Term expires 1906).

G. W. KELLY, (Term expires 1908).

Officers

FRANK O. SINCLAIR, C. E., Superintendent.

MISS KATHARINE M. McCAFFREY, Registrar.

MISS J. PEARL TEACHOUT, Office Assistant.

JAMES J. CANNON, Engineer at Pumping Station.

WILLIAM CASSIDY, Foreman.

OSCAR HEININGER, Chief Inspector.

SEVENTEENTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

GENTLEMEN:—As required by ordinance, the Board of Water Commissioners herewith submit their report for the year ending December 31, 1905:

The receipts from water rates for the year have been \$45,111.42. The unpaid water bills, which are forty-one in number, amount to \$199.18. No places are off for non-payment.

The pumpage for the year is 385,442,700 gallons, an increase over last year of 25,129,975 gallons. This increase was no doubt due to the waste to prevent freezing during the winter of 1904-1905.

A deposit to the sinking fund of \$3,406.17 has been made, which is \$1,151.19 in excess of the amount required by the City Charter.

Deposits to the sinking fund have now been made to the amount of \$50,313.39, which, with their interest, are now included in the sinking fund in the custody of the City Treasurer.

The bonded debt of the city on account of this department is as follows:

Four per cent. bonds, due in 1906.....	\$160,000 00
Four per cent. bonds, due in 1914.....	30,000 00
Four per cent. bonds, due in 1919.....	58,000 00
Total.....	<u>\$248,000 00</u>

The appropriation for 1905 has been sufficient to meet all the expenses of the department, including interest, \$3,113.64 for construction, and deposit to the sinking fund of \$1,151.19 in excess of the 5 per cent. of the appropriation required by ordinance.

The department has also paid out of its appropriation \$1,280.58 for lowering mains in streets where they were frozen during the extremely cold winter of 1904-1905. This is an extraordinary expense, which, had the said winter been as usual, would not probably have been incurred.

The department has on hand \$3,000.00 worth of cast iron pipe, also paid for out of its appropriation for 1905.

The biological and chemical examinations made at the Laboratory of the State Board of Health have been continued, and are tabulated in the accompanying report of the Superintendent.

Respectfully submitted,

THOS. F. CONLON,	} Water
J. E. LANOU,	
G. W. KELLY.	
	} Commissioners.

THIRTY-NINTH ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS.

To the Honorable Board of Water Commissioners of the City of Burlington, Vt.:

GENTLEMEN:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1905, as taken from the books of the office:

RECEIPTS.

From L. C. Grant, City Treasurer:—

Transfer to sinking fund required.....	\$ 2,254 98
Transfer to construction required	3,113 64
Balance appropriation for current expenses.	39,730 98

Total amount of appropriation.....	\$45,099 60
Amount received for material and labor....	781 66
Total receipts from City Treasurer....	\$45,881 26

DISBURSEMENTS.

Construction—

Pay rolls, mains	\$ 1,389 28
Pipe	775 31
Pay rolls, services	580 00
Material for services	203 00
Lead and gates	106 05
Two fire hydrants	60 00
Total construction.....	\$ 3,113 64

MAINTENANCE.

Current—

Pay rolls	\$3,216 58
Pipe and castings	3,533 37
Salary of Superintendent	1,500 00
Frozen services	815 63
Salary of Registrar	560 00
Rent and sprinkling tax	404 62
Plumbers' bills	337 47
Stable expenses	310 23
Hydrant inspection and repairs	261 46
Material for management and repairs.....	244 86
Tank cleaning and repairs	208 12
Thawing apparatus	201 36
Repair of tools	189 71
Thawing frozen pipes	175 55
Fuel	167 44
Office expenses	161 27
Printing, advertising and postage	139 70
Telephone rent	137 22
Reservoir cleaning and repairs	119 76
T. F. Conlon, Water Commissioner.....	100 00
J. E. Lanou, Water Commissioner.....	100 00
Damages	70 48
G. W. Kelly, Water Commissioner.....	66 67
J. J. Flynn, Water Commissioner.....	33 33
Investigations	15 00

 \$13,069 83
Replacing cement pipe—

Pay rolls	\$847 86
Pipe	538 03
	<hr/> \$ 1,385 89

Lowering mains—

Pay rolls	\$ 1,280 58
	<hr/> \$15,736 30

INTEREST.

Interest on debt	\$ 9,920 00
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WATER DEPARTMENT.

7

PUMPING.

Low service station—

Pay rolls	\$ 2,981 91
Fuel	5,796 78
Oil and packing	224 26
Repairs to machinery	160 11
Repairs to tools and supplies.....	103 19
Buildings and grounds	31 23
	<hr/>
	\$ 9,297 48

High service station—

Building and grounds	\$123 06
Fuel and light	67 60
	<hr/>
	\$ 190 66

Steam pump—

Repairs and care	\$ 17 27
Fuel	7 99
	<hr/>
	\$ 25 26

Motor—

Care	\$262 99
Repairs	57 26
Supplies	12 95
	<hr/>
	\$ 333 20
	<hr/>
	\$ 549 12
	<hr/>
	\$ 9,846 60

METERS.

Pay rolls	\$3,002 08
Meters	695 31
Material for repairs	155 22
Supplies	5 94
	<hr/>
	\$ 3,858 55
Total maintenance.....	<hr/>
	\$39,361 45

TRANSFERS.

To sinking fund, 5 per cent. required by charter.....	\$ 2,254 98
Sinking fund, surplus funds	1,151 19
	<hr/>
Total transfers	\$ 3,406 17
Total disbursements	45,881 26

RECAPITULATION.

RECEIPTS.

From L. C. Grant, City Treasurer.....\$45,881 26

DISBURSEMENTS.

Maintenance—

Current\$15,736 30

Pumping 9,846 60

Meters 3,858 55

\$29,441 45

Interest 9,920 00

Total maintenance\$39,361 45

Transfers 3,406 17

Construction 3,113 64

Total disbursements\$45,881 26

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates\$ 6,821 16

Meter rates 38,290 26

Total receipts.....\$45,111 42

DISBURSEMENTS.

L. C. Grant, City Treasurer.....\$45,111 42

UNPAID WATER RATES.

Meter rates, twenty in number.....\$ 53 63

Schedule rates, twenty-one in number..... 145 55

Total unpaid water rates forward to 1906.....\$ 199 18

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1905, in the office of the Superintendent of the City Water Works, and find them correct.

WATER DEPARTMENT.

9

We also find that the provisions of the water ordinance, relative to collection of water rates, discount, penalty, etc., have been fairly and impartially administered.

T. A. DELANY,
THOMAS FAILEY,
HARRY H. ROSENBERG, } Auditors.

STATEMENT OF ASSESSMENTS AND CURRENT EXPENDITURES FOR THE YEAR ENDING DEC. 31, 1905.

The paid assessments of this statement are the receipts for the year, less whatever portion of the same was assessed previous to January 1, 1905. The unpaid are the unpaid of January 1, 1906, less whatever portion of the same are of more than one year's standing.

ASSESSMENTS.		DISBURSEMENTS.	
	<i>Paid.</i>		
Meter rates,	\$38,276 24	Interest	\$ 9,920 00
Sched. rates,	6,821 16	Current,	\$16,685 13
	<u>\$45,097 40</u>	Pumping,	8,897 77
Mat. and labor,	781 66	Meters,	3,858 55
	<u>\$45,879 06</u>		<u>\$29,441 45</u>
			<u>\$39,361 45</u>
	<i>Unpaid.</i>		
Meter rates,	39 61		
Sched. rates,	155 55	Excess of assessments	
Mat. and labor,	674 95	over disbursements for	
	<u>\$ 870 11</u>	the year 1905.....	\$ 7,387 72
	<u>\$46,749 17</u>		<u>\$46,749 17</u>

WATER PUMPED.

1905.	Gallons.
January	24,705,275
February	32,348,075
March	43,308,575
April	32,886,600

May	33,224.725
June	31,711,250
July	40,787,275
August	32,037,625
September	29,288,550
October	30,133,200
November	29,206,950
December	25,804,600
<hr/>	
Total 1905	385,442,700
Total 1904	360,312,725
<hr/>	
Increase in 1905.....	25,129,975
Daily average in 1905	1,056,008
Daily average in 1904	987,158

SERVICES.

There have been added one hundred and five services of the following sizes:

Ninety-four	½ inch
Four	¾ inch
Three	1 inch
Three	2 inch
One	6 inch

Four services were discontinued during the past season, Nos. 28 Clarke street, 22 North Battery street, 129 Bank street and 76 North Union street.

Of the one hundred and five new services added during the season. four replace discontinued services, and forty-seven replace services found, owing to change of grade or other cause, to have less than six feet cover.

HYDRANTS.

Two new public hydrants have been set, one at the southwest corner of Park avenue and Pine street, and the other at the southwest corner of Shelburne street and Lyman avenue.

Total number of public hydrants	181
Total number of private hydrants.....	37
<hr/>	
Total	218

SUPPLY PIPE.

	<i>Feet.</i>
Two inch in Interval road	2,321
Two inch in Hyde street	252
One inch in Crowley street, westerly from North Bend street..	156
Total length of supply pipe now in use.....	25,408

MAINS.

New mains have been laid as follows:

With four inch cast iron pipe—

	<i>Feet</i>
Bay View street, easterly from dead end, to connect with main on Willard street	406
Bissell street, northerly	88

With six inch cast iron pipe—

King street, westerly from Union street	255
Elm street, southerly from Spruce street	263
Elm street extension, northerly from Maple street.....	252

LENGTH OF PIPE NOW IN USE.

Cement	22,245 feet.	About 4 miles
Cast iron	187,958 feet.	About 36 miles
Total.....	210,203 feet.	About 40 miles

GATES.

Gates have been set in the following locations:

Elm and Spruce streets	1 6-inch.
Elm and Maple streets	2 6 "
Blodgett and Strong streets	1 6 "
King and Union streets	1 6 "
Bay View and Willard streets	1 4 "

Total added	6
Total now in use	679

SMALL STOP-GATES.

Four small stop-gates were added; two in Interval road, one in Hyde street and one in Crowley street.

Total number of small stop-gates now in use..... 70

SINKING FUND.

Deposits to this fund have been made with the City Treasurer as follows:

Dec. 31, 1899, construction account for the year.....	\$ 2,726 42
Dec. 31, 1900, construction account for the year.....	2,200 00
Dec. 31, 1901, construction account for the year.....	6,421 50
Dec. 31, 1902, construction account for the year.....	1,174 17
Dec. 31, 1903, to apply on North avenue extension account..	2,985 74
Feb. 3, 1904, balance of North avenue extension account...	1,310 20

To be applied in reduction of the bonded debt:

Sept. 10, 1897, 5 per cent. required by charter.....	\$ 2,360 25
Aug. 4, 1898, 5 per cent. required by charter.....	2,259 16
Aug. 10, 1899, 5 per cent. required by charter.....	2,297 94
Aug. 14, 1900, 5 per cent. required by charter.....	2,439 13
Aug. 8, 1901, 5 per cent. required by charter.....	2,454 67
Aug. 7, 1902, 5 per cent. required by charter.....	2,391 58
Aug. 5, 1903, 5 per cent. required by charter.....	2,140 87
Aug. 4, 1904, 5 per cent. required by charter.....	2,159 98
Aug. 11, 1905, 5 per cent. required by charter.....	2,254 98
Nov. 9, 1899, surplus funds.....	4,000 00
Dec. 31, 1899, surplus funds.....	1,531 17
Dec. 31, 1900, surplus funds.....	9,857 45
Dec. 31, 1901, surplus funds.....	5,210 97
Dec. 31, 1902, surplus funds.....	6,894 49
Dec. 31, 1903, surplus funds.....	869 31
Dec. 31, 1904, surplus funds.....	40 25
Dec. 31, 1905, surplus funds.....	1,151 19

Total.....\$50,313 39

HIGH SERVICE.

The consumption on the high service, as indicated by the pumping record of that station, was about fifteen million gallons, or about 4 per cent. of that of the low service. Of this amount, about 80 per cent. was measured to consumers through meters; 5 per cent. was the estimated loss in the meter, and about 15 per cent. remains unaccounted for.

About 94 per cent. of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 6 per cent. by the auxiliary steam pump.

METERS.

There are now in use 2,864 meters, an increase of 94 over last year. Of the water pumped, about 54 per cent. has passed through meters yielding about 85 per cent. of the revenue.

Respectfully submitted,

FRANK O. SINCLAIR,
Superintendent.

PARTS IN 1,000,000.

Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	ODOR.		RESIDUE.				AMMONIA.		Hardness.	Nitrogen as Nitrates.	Nitrogen as Nitrates.
						Cold.	Hot.	Total solids.	Loss on Ignition	Fixed solids.	Free.	Albuminoid.	Chlorine.			
31345	1-4-05	1-4-05	Slight.	Very slight.	25	Faint veg.	F't. veg.	79.5	22.0	57.5	.004	.114	1.0	50.0	.000	.000
31450	1-11-05	1-11-05	Slight.	Very slight.	16	F't. arom.	F't. arom.	65.0	11.0	54.0	.006	.092	1.1	51.4	.200	.000
31615	1-18-05	1-18-05	Slight.	Slight.	14	F't. arom.	F't. arom.	71.0	21.0	50.0	.002	.114	1.2	58.6	.200	.000
31812	1-25-05	1-25-05	Slight.	Very slight.	16	Faint veg.	F't. veg.	69.0	15.0	54.0	.002	.100	1.1	51.4	.200	.000
31904	2-1-05	2-1-05	Slight.	Very slight.	14	D't earthy	D't earthy	66.0	15.0	51.0	.006	.086	1.2	51.4	.200	.000
32149	2-8-05	2-8-05	Slight.	Very slight.	16	V'y ft veg	V'y ft veg	65.0	15.0	50.0	.006	.114	1.1	51.4	.200	.000
32183	2-10-05	2-10-05	Slight.	Very slight.	26	F't. arom.	F't. arom.	70.0	14.0	56.0	.002	.108	1.1	57.1	.200	.000
32184	2-10-05	2-10-05	Distinct.	Slight.	18	Faint veg.	F't. veg.	70.5	16.5	54.0	.002	.116	1.1	55.7	.200	.000
32269	2-15-05	2-15-05	V'y slight.	V'y slight.	16	None.	None.	68.0	14.0	54.0	.012	.154	1.2	54.3	.250	.000
32389	2-22-05	2-22-05	Slight.	Very slight.	20	V'y ft veg	V'y ft veg	72.0	14.0	58.0	.002	.104	1.1	57.1	.200	.000
32520	3-1-05	3-1-05	Slight.	Very slight.	14	Faint veg.	F't. veg.	65.5	13.5	52.0	.008	.118	1.2	55.7	.220	.000
32639	3-8-05	3-8-05	Slight.	Very slight.	16	Faint veg.	F't. veg.	69.0	15.0	54.0	.012	.106	1.3	52.9	.190	.000
32748	3-15-05	3-15-05	Slight.	Very slight.	16	Faint veg.	F't. veg.	62.5	18.5	44.0	.018	.102	1.2	61.4	.200	.000
33029	3-29-05	3-29-05	V'y slight.	V'y slight.	17	None.	None.	67.0	13.0	54.0	.012	.118	1.2	51.4	.200	.000
33168	4-5-05	4-5-05	Slight.	Slight.	20	Faint veg.	F't. veg.	76.0	18.0	58.0	.018	.160	1.1	58.0	.200	.000
33325	4-12-05	4-12-05	Distinct.	V'y slight.	16	D't earthy	D't earthy	68.0	14.0	54.0	.024	.102	1.0	48.6	.200	.000
33885	5-22-05	5-22-05	None.	Very slight.	16	Faint veg.	F't. veg.	69.0	14.0	55.0	.018	.146	1.3	54.3	.220	.000
33436	4-19-06	4-19-06	Distinct.	V'y slight.	20	D't earthy	D't earthy	63.0	13.0	50.0	.009	.084	1.2	45.7	.200	.000
33583	4-28-05	4-28-05	Distinct.	V'y slight.	26	D't earthy	D't earthy	70.0	13.0	50.5	.006	.100	1.1	....	.250	.000
33698	6-8-05	6-8-05	Distinct.	V'y slight.	16	Faint veg.	F't. veg.	73.0	13.0	60.0	.020	.118	1.1	....	.210	.000
33845	6-10-05	6-10-05	Distinct.	V'y slight.	20	None.	None.	58.5	14.0	44.5	.014	.142	1.0	....	.190	.000
33955	5-17-05	5-17-05	Slight.	Very slight.	26	Faint veg.	F't. veg.	71.0	24.0	47.0	.004	.128	1.0	....	.200	.000
34068	5-24-05	5-24-05	Slight.	Very slight.	20	V'y faint.	V'y faint.	64.0	14.0	50.0	.008	.090	1.0	....	.250	.000
34168	5-31-05	5-31-05	Distinct.	V'y slight.	28	None.	None.	72.0	13.0	59.0	.004	.116	1.0	....	.300	.000

SOURCE.	BACTERIA.			MICROSCOPICALLY.	REMARKS.
	Bacteria in 1 c.c.	B. Coll.	B. Coll per c.c.		
Tap at laboratory	...	Absent		Negative.	.....
Tap at laboratory	200	"		Negative.	.....
Tap at laboratory	80	"		Negative.	.....
Tap at laboratory	40	"		Small am't amorphous mat.	.....
Tap at laboratory	50	"		Negative.	.....
Tap at laboratory	20	"		Negative.	.....
Tap at laboratory	200	"		No vegetable life found.	.....
Tk. Hendee's house	80	"		Amorphous debris.	.....
Tap, Hendee's house	120	"		Amorphous debris.	.....
Tap at laboratory	40	"		Negative.	.....
Tap at laboratory	150	Present.		Negative.	.....
Tap at laboratory	90	Absent		Negative.	.....
Tap at laboratory	270	Present		Negative.	.....
Tap at laboratory	400	"		Small am't amorphous mat.	.....
Tap at laboratory	•	Absent		Negative.	.....
Tap at laboratory	150	"		Negative.	.....
Tap at laboratory	400	Present		Small am't amorphous mat.	.....
Tap at laboratory	•	Absent		Negative.	.....
Tap at laboratory	200	Present		Small am't amorphous mat.	.....
Tap at laboratory	70	Absent		Negative.	.....
Tap at laboratory	700	Present 2		Negative.	.....
Tap at laboratory	120	Absent		Negative.	.....
Tap at laboratory	80	Present 8		Negative.	.....

*Impossible to correct.

PARTS IN 1,000,000.

Number.	Collected.	Examined.	Turbidity.	Sediment.	ODOR.			RESIDUE.			AMMONIA.		Chlorine.	Hardness	Nitrogen as Nitrates.	Nitrogen as Nitrates.
					Color.	Cold.	Hot.	Total solids.	Loss on Ignition.	Fixed solids.	Free.	Albuminoid.				
34334	6-7-05	6-7-05	Distinct.	V'y slight.	50	Faint veg.	F't veg.	75.0	15.0	60.0	.022	.130	1.2	...	.200	.000
34404	6-14-05	6-14-05	Distinct.	V'y slight.	80	Faint veg.	F't veg.	64.5	16.5	48.0	.036	.134	1.1	...	.140	.000
34741	7-5-05	7-5-05	Distinct.	Slight.	80	F't arom.	F't arom.	70.0	20.0	50.0	.030	.130	.9	...	.170	.000
34860	7-12-05	7-12-05	Distinct.	Slight.	80	D'd arom.	D'd arom.	71.0	21.0	50.0	.036	.160	1.0	...	.200	.000
34955	7-19-05	7-19-05	Slight.	Very slight.	28	D'd arom.	F't arom.	71.0	21.0	50.0	.016	.138	1.0	...	.190	.000
35055	7-26-05	7-26-05	Slight.	Very slight.	20	Faint veg.	F't veg.	65.5	17.5	48.0	.036	.122	1.0	...	.150	.000
35177	8-2-05	8-2-05	Distinct.	Slight.	26	D'y veg.	D'y veg.	76.0	23.5	52.5	.016	.130	1.1	...	.140	.000
35271	8-9-05	8-9-05	Dist't.	Considerable.	18	D'd arom.	D'd arom.	70.0	17.5	52.5	.022	.160	1.0	...	.160	.000
35380	8-17-05	8-17-05	Distinct.	Slight.	28	F't veg.	F't veg.	61.0	15.5	45.5	.018	.130	1.0	...	.160	.000
35466	8-23-05	8-23-05	Distinct.	Slight.	80	F't veg.	F't veg.	66.5	16.5	50.0	.022	.124	1.0	...	.160	.000
35610	8-31-05	8-31-05	Slight.	Slight.	20	F't veg.	F't veg.	71.0	26.0	45.0	.014	.124	1.2	...	.170	.000
35701	9-6-05	9-6-05	V'y slight	V'y slight	83	Dist veg.	Dist veg.	70.0	19.0	51.0	.018	.122	1.1	...	.180	.000
36062	9-27-05	9-27-05	Slight.	Slight.	80	F't veg.	F't veg.	67.0	17.0	50.0	.028	.130	1.2	...	.120	.000
36208	10-4-05	10-4-05	Distinct.	Slight.	82	None.	None.	80.0	34.0	46.0	.014	.130	1.2	...	.100	.000
36311	10-11-05	10-11-05	Distinct.	Slight.	26	F't arom.	F't arom.	95.0	37.0	58.0	.006	.120	1.1	...	.110	.000
36623	10-25-05	10-25-05	Distinct.	V'y slight.	28	F't arom.	F't arom.	...	...	...	.006	.104	1.1	45.7	.180	.000
36779	11-1-05	11-1-05	Distinct.	Slight.	80	D'd arom.	D'd arom.	...	...	...	.008	.108	1.2	44.3	.160	.000
36967	11-8-05	11-8-05	Slight.	Slight.	28	D'd arom.	D'd arom.	...	...	...	.024	.140	1.2	44.3	.180	.000
37138	11-15-05	11-15-05	Slight.	Slight.	16	D't arom.	D't arom.	...	...	...	.006	.124	1.2	47.1	.160	.000
37309	11-22-05	11-22-05	Slight.	Very slight.	16	V'y ft veg	V'y ft veg	...	...	...	.036	.124	1.0	...	.180	.000
37478	11-29-05	11-29-05	Very slight.	Slight.	10	None.	None.	...	...	...	.004	.126	1.2	51.4	.000	.000
37600	12-6-05	12-6-05	Slight.	Slight.	10	...	...	...	...	...	.012	.094	1.0	47.1	.240	.000
37955	12-13-05	12-13-05	Slight.	Slight.	18	...	...	...	...	...	.006	.100	1.0	47.1	.190	.000
38112	12-20-05	12-20-05	V'y slight	V'y slight	23	20.	20.	...	...	...	.012	.104	1.0	51.4	.220	.000
38300	12-27-05	12-27-05	Slight.	Very slight.	16	20.	20.	...	...	...	.022	.110	1.0	47.1	.170	.000

SOURCE.	BACTERIA.			MICROSCOPICALLY.	REMARKS.
	Bacteria in 1 c.c.	B. Coll.	B. Coll per c.c.		
Tap at laboratory	80	Absent	Negative.	.....	.....
Tap at laboratory	Liquified	"	Negative.	.....	.....
Tap at laboratory	200	Present	Negative.	.....	.....
Tap at laboratory	30	Absent	Small am't amorphous mat.	.....	.....
Tap at laboratory	130	Present	Negative.	.....	.....
Tap at laboratory	120	Absent	Negative.	.....	.....
Tap at laboratory	Liquified	"	Negative.	.....	.....
Tap at laboratory	160	"	Negative.	.....	.....
Tap, C.P. Moat, city	180	"	Negative.	.....	.....
Tap at laboratory	480	"	Negative.	.....	.....
Tap at laboratory	500	"	Negative.	.....	.....
Tap at laboratory	80	"	Negative.	.....	.....
NO. BACTERIA PER C. C.					.....
Tap at laboratory	...	Absent.	Room Temp.	Ratio of liquid to non-liquid (lyng. col.)	Usual condition.
Tap at laboratory	...	Present	200	50%	Shows presence of colon bacillus.
Tap at laboratory	...	Absent	180	50%	Usual condition.
Tap at laboratory	...	"	100	60	Usual condition.
Tap at laboratory	...	"	90	60	Usual condition.
Tap at laboratory	...	"	40	100%	Usual condition.
Tap at laboratory	...	"	100	50%	Usual condition; free ammonia & chlorine higher than [normal for the locality.
Tap at laboratory	...	Present	200	14	Shows evidence of contamination.
Tap at laboratory	...	"	120	20	Chlorine high; usual condition.
Tap at laboratory	...	"	70	14	Shows evidence of contamination.
Tap at laboratory	...	Absent	500	100	Sewage bacilli present; evidence of pollution.
Tap at laboratory	...	"	200	44	Usual condition; chlorine above normal for locality.
Tap at laboratory	...	"	90	89%	Chlorine above normal.
Tap at laboratory	...	Present	50	14	Usual condition; chlorine above normal.
Tap at laboratory	...	Present	50	14	Shows presence of sewage bacteria.

SUMMARY OF STATISTICS

For the year ending December 31, 1905.

IN FORM RECOMMENDED BY THE

New England Water Works Association.

Burlington City Water Works.

Burlington, Chittenden County, Vermont.

GENERAL STATISTICS.

Population by census of 1900, 18,640.

Date of construction, 1867-8.

By whom owned, City.

Source of supply, Lake Champlain.

Mode of supply (whether gravity or pumping), pumping.

PUMPING STATISTICS.

1. Builders of pumping machinery, H. R. Worthington.
 2. Description of fuel used,

<ol style="list-style-type: none"> a. Kind, bituminous. b. Brand of coal. c. Average price of coal per gross ton, delivered, \$4. d. Percentage of ash. e. Wood price per cord, none used. 	{
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 3. Coal consumed for the year, 2,898,380 pounds.
 4. (Pounds of wood consumed) \div 3 = equivalent amount of coal, 200,000 pounds.
 - 4a. Amount of other fuel used.
 5. Total equivalent coal consumed for the year = (3) + (4), 3,098,380 pounds.
 6. Total pumpage for the year, 385,442,700 gallons, with allowance for slip.
 7. Average static head against which pumps work, 289 feet.
 8. Average dynamic head against which pumps work, 316 feet.
 9. Number of gallons pumped per pound of equivalent coal (5), 121.17 gallons.
 10. Duty = $\frac{385,442,700 (6) \times 8.34 \times 100 \times 316 (8)}{3,098,380 (5)} = 32,785,233$.
- Cost of pumping, figured on pumping station expenses, viz., \$9,297.48.

11. Per million gallons pumped, \$24.12.
12. Per million gallons raised one foot (dynamic), \$0.076.

FINANCIAL STATISTICS.

RECEIPTS.		EXPENDITURES.	
Balance brought forward:		Water Works maintenance:	
(a) From ordinary (main-		AA. Operation (manage-	
tenance) receipts, \$45,099 60		ment and repairs),	\$29,441 45
(b) From extraordinary		BB. Special:	
receipts (bonds, etc.) 781 66		CC. Total maintenance,	29,441 45
Total .....\$45,881 26		DD. Interest on bonds,	9,920 00
From water rates:		EE. Payment of bonds,	
A. Flx. rates, \$ 6,821 16		FF. Sinking fund,	3,406 17
B. Meter rates, 38,290 26		Water Works construction:	
C. Total from consumers, \$45,111 42		GG. Extension of	
D. For hydr'ts, \$ 3,580 00		mains,	\$2,270 64
E. Fountains, 104 05		HH. Extension of	
F. For street		services,	783 00
watering, 1,590 27		II. Extension of	
G. For public		meters,	695 31
buildings, 798 62		JJ. Special,	60 00
H. For mis. uses,		KK. Total construction,	\$3,808 95
I. Gen'l app'n, 45,099 60		LL. Unclassified expenses,	
J. Total from mun. debts,		MM. Balance, \$	
K. From tax levy,		(aa) Ordinary, \$	
L. From bond issue,		(bb) Extraordinary	
M. From other sources,		total balance,	\$.....
	\$ 781 66	N. Total,	\$.....
	\$45,893 08		
N. Total,	\$.....		

Disposition of balance	\$
O. Net cost of works to date.....	490,076 07
P. Bonded debt at date.....	248,000 00
Q. Value of sinking fund at date.....	56,406 00
R. Average rate of interest, 4 per cent.	

STATISTICS OF CONSUMPTION OF WATER.

1. Estimated total population at date 20,000
2. Estimated population on lines of pipe 19,800
3. Estimated population supplied 19,600
4. Total consumption for the year 385,442,700 gallons
5. Passed through meters 208,139,058 gallons
6. Percentage of consumption metered, 54 percent.

7. Average daily consumption	1,056,008 gallons
8. Gallons per day to each inhabitant.....	52
9. Gallons per day to each consumer	54
10. Gallons per day to each tap	262
11. Cost of supplying water, per million gallons, figured on total maintenance (item CC)	\$76 38
12. Total cost of supplying water, per million gallons, fig- ured on total maintenance + interest on bonds....	102 12

STATISTICS RELATING TO DISTRIBUTION SYSTEM.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Kind of pipe, galvanized, cast iron and lead.
2. Sizes, from 4 inch to 30 inch.	17. Sizes, $\frac{1}{2}$ to 6 inches.
3. Extended 1,264 feet during the year.	18. Extended, 2,625 feet.
4. Discontinued — feet during the year.	19. Discontinued, 1,275 feet.
5. Total now in use, about 40 miles.	20. Total now in use, 19.63 miles.
6. Cost of repairs per mile, \$—.	21. Number of service taps added during year, 54.
7. Number of leaks per mile, —.	22. Number now in use, 3,634.
8. Length of pipes less than 4 inches diam., 4.8 miles.	23. Average length of service, 25 feet.
9. Number hydrants added during the year (public and private), 2.	24. Average cost of service for the year, \$13.50.
10. Number hydrants (public and private) now in use, 218.	25. Number of meters added, 94.
11. Number of stop-gates added during year, 6.	26. Number now in use, 2,864.
12. Number of stop-gates now in use, 679.	27. Percentage of services metered, 79 per cent.
13. Number of stop-gates smaller than 4 inch, 70.	28. Percentage of receipts from metered water ($B \div C$), 85 per cent.
14. Number of blow-offs, 14.	29. Number of motors and elevators added, 4.
15. Range of pressure on mains, 70 to 85 lbs. average.	30. Number now in use, 39.

REPORT OF THE SPECIAL COMMITTEE ON WATER.

To the Honorable Common Council of the City of Burlington, Vermont:

GENTLEMEN:—Your Committee, appointed to consider the improvement of the water supply of Burlington, begs to submit the following report:

We employed an expert, Mr. M. N. Baker, of the Engineering News of New York, a gentlemen well known as an authority on questions of water supplies and their purification, who has come to Burlington, looked over the ground carefully, collected data and made a report which we submit along with ours. We attended the meeting of the New England Water Works Association, held in New York, September 13-16, and visited and inspected the filtering plants at Little Falls, N. J., Pelham, N. Y., Albany and East Albany, N. Y., and Lawrence, Mass. We have endeavored by reading, personal observation and consulting with men of practical knowledge of water purification, to gain as much information as possible on the general subject, and on the special conditions which confront our own city. We have reached the following conclusions:

1. The quality of our water supply needs to be improved. The necessity of such improvement is shown by the results of bacterial and chemical examinations of the water and by the vital statistics of the city. The State Laboratory examinations, made nearly every day in 1904, show that over forty per cent. (40%) of the specimens were polluted with sewage. The extensive series of careful examinations made last year by Mr. M. O. Leighton, for the United States Government, demonstrate the existence of sewage pollution all over Burlington and Shelburne bays. As the germs of typhoid and other water borne diseases are liable to be present in sewage, this shows a dangerous condition of things. With regard to our vital statistics, the total death rate, and the death rate from typhoid fever, while not remarkably high, are decidedly higher than they ought to be in a place with the natural advantages of Burlington; while the death rate from diarrhoeal diseases is higher than it ought to be anywhere.

That the cause of this condition is probably in our sewage-polluted water, is shown by the marked diminution in the typhoid and diar-

rhoecal death rates which occurred immediately after the extension of the intake into purer water in 1894, and by the gradual rise in the death rates since then corresponding to the pollution of the water by the gradually increasing amount of sewage poured into the lake from our own sewers and from Winooski river. Our typhoid and diarrhoeal death rates now approach those which prevailed before the extension of the intake.

Corroboration of the theory that this condition is due to water pollution is found in the experience of other cities, which, after properly purifying their polluted water supplies, have always observed a lowering of these death rates, remarkable in the case of typhoid fever, and noticeable in the case of diarrhoeal diseases and of some others which are not commonly supposed to have any relation to water supply.

2. We should continue to take our water from the lake. It is considered inadvisable to change the present source of supply for the following reasons: It is inexhaustible, it is very accessible, the pumping outfit and reservoirs are already installed and handle the water satisfactorily and the water is clear, soft, of agreeable taste and in fact has no drawback excepting the pollution already referred to, the removal of which is perfectly practicable. The question of changing to a gravity supply was considered sixteen years ago, by Mr. F. H. Crandall, at that time superintendent of water works, and all available sources within thirty miles of Burlington were carefully investigated. The conclusion was reached that, "No improvement in quality or lessening in expense, but rather the reverse, is to be expected from change of our present supply." (See report of Superintendent of Water Works, City Reports, 1889 and 1890). As regards the substitution of artesian wells for the lake as a source of supply, your committee is of the opinion that there is too little certainty that the quality and quantity of artesian well water would be satisfactory for both manufacturing and drinking purposes, to make it advisable to resort to the wells.

3. The question to be decided then, is as to the best method of purifying the water which we now have. Your committee is convinced that a properly conducted system of filtration will answer the purpose better than anything else which has yet been devised. Filtration is not, as is commonly supposed, merely a mechanical straining out of impurities. In one type of filter, the bacteria of disease are re-

moved by being caught in a coagulum formed by the addition of chemicals to the water, which coagulum cannot pass through the filter. In another type the bacteria of disease are destroyed by the harmless water bacteria, which grow in great numbers in the layer of organic material which forms on the surface of the filter. In this way more than 99 per cent. of the bacteria is removed from the water which flows from the filter, and the insignificant number which remains is too small to have any effect on the consumers of the water. This is shown by the experience of numerous cities in Europe and in this country, among which may be mentioned London, Hamburg and St. Petersburg, and on this side of the ocean, Albany, N. Y., Lawrence, Mass., and Lorain, Ohio. All of these cities take their water from polluted sources and the introduction of filtration has caused a reduction of from 70 to 90 per cent. in their death rate from typhoid. That typhoid has not entirely disappeared from these cities is due to the fact that a few cases are imported from other places, and that a few more are caused by infection of milk or some other article of food. The advantages of filtration are now so well understood that filter plants are being constructed all over the country. New Haven, Philadelphia, Washington and Louisville are a few of the cities which either are building, or have just built filters.

The subject of sewage purification as a means of improving our water supply has been considered by your committee. The question whether it would be best to purify our sewage instead of filtering our water was put to Mr. Baker, who replied in a letter, which is appended to his report, as follows:

"There is no system of purification in practical use which can be relied upon to so purify sewage as to warrant its discharge into drinking water."

Other sanitary experts with whom your committee conversed made similar answers to the question.

The fact seems to be, that while sewage can be rendered odorless and non-putrescible, the elimination of bacteria from it cannot be made perfect enough to render it a safe addition to a water supply, unless the water is filtered before it reaches the consumer. Therefore, it would be necessary to filter the water, even if the sewage were purified. It is not intended to underestimate the importance of sewage purification. The gradual increasing pollution of Lake Champlain

with sewage becomes every year a more serious matter and in the near future something ought to be done to remedy it. But the problem which engages our attention at present is to give the city the purest possible drinking water, and this surely can be better accomplished by completely removing the disease germs immediately before the water reaches the consumer, than by incompletely removing them from only one source of pollution. For our water supply is polluted by the sewage of Winooski, Fort Ethan Allen and the poor farm as well as by our own sewage. After we have purified our drinking water our next care should be to purify our sewage and thus minimize the pollution of the lake; but the pure drinking water should come first.

In view of these conditions, filtration of the lake water is recommended.

CHOICE OF FILTERS.

5. Two kinds of filters are used in this country; the "mechanical" and the "slow sand" filters. Your Honorable Board is referred to Mr. Baker's report for a detailed description of these, as well as for an elaboration of the other points touched upon in this report.

Your committee has investigated some of the best specimens of both kinds of filters, and has gained its information from the scientific and practical men in charge of them. We find that both kinds do good work, but that the mechanical filter does best in turbid, highly colored waters of high alkalinity, such as are common in the Mississippi Valley, while the slow sand filter is better adapted to clear water of low alkalinity, like that of Lake Champlain, and most other bodies of water in New England.

The opinion which Mr. Baker expressed in his report in favor of a sand filter, he expressed still more strongly in conversation with us; and similar opinions were expressed by everyone with whom we conversed, who was not interested in the sale of mechanical filters. Moreover, on hearing our description of the water supply of Burlington, a gentleman in charge of a very large and fine mechanical filter plant, said at once that a slow sand filter would answer our purpose better. Although the slow sand filter is much more expensive to install than the mechanical, the weight of expert testimony altogether favors the opinion that it is much better adapted to our local condi-

tions than the mechanical, while the greater expense of construction may be offset to a certain extent by the fact that the expense of running it is somewhat less.

We therefore recommend the "slow sand filter."

SUMMARY.

1. Something should be done to improve the character of our water supply.
2. A change in the source of supply is inadvisable.
3. Sewage purification, while it prevents sewage from becoming a nuisance, cannot be made so complete as to render purified sewage a safe addition to drinking water, unless such water is subsequently filtered.
4. Properly conducted filtration will, for all practical purposes, perfectly purify water which is much more badly polluted than that of Lake Champlain is ever likely to be.
5. We therefore recommend filtration of the water from our present source of supply, Lake Champlain, as the best means of giving the city of Burlington an adequate supply of pure water.
6. The method of filtration which we recommend for the water of Lake Champlain is that known as "The Slow Sand Filtration Method."

ESTIMATES.

In presenting costs of construction and operation of a filter for our city, it must be borne in mind that the same are approximations. More definite figures could be given only after detailed plans were made and the sands of the different beds in the vicinity had been analyzed, and one of the beds selected from which to get the supply.

Estimating on the basis of our present consumption of an average of 1,000,000 gallons and a maximum of 1,250,000 per day, and that the rate of filtration is 3 000,000 gallons per acre per day, the effective area of filter required for our present consumption need not be more than three-fourths ($\frac{3}{4}$) of an acre, divided into three beds of one-fourth ($\frac{1}{4}$) acre each.

It may be well to remark here that the filter could be so planned that an additional bed of one-fourth ($\frac{1}{4}$) acre could be added from

time to time as needed. The reason for suggesting a filter with no special provision as to capacity for the future, is that something more is being learned each year about filtering water, and improvements are being made, the future additions if any, could have these later developments, and there would be less of the old filter to be made over if it seemed desirable to apply the later improvements to it also.

Your committee have considered two locations for the filter, one at the lake shore near the pumping station, and one on the hill near the present reservoirs.

ESTIMATE FOR FILTER AT LAKE SHORE.

Low lift pump	\$ 5,000 00
Filter	40,000 00
Additional cost of foundations and clear water basin	5,000 00
Land, two acres	5,000 00
Total.....	\$55,000 00

ESTIMATE FOR FILTER ON THE HILL.

New pipe line	\$15,000 00
Filter	40,000 00
Land, two acres	3,000 00
Total.....	\$58,000 00

Your committee recommends locating the filter on the hill, and begs leave to make mention of the following as some of the reasons for so doing:

The location on the hill offers a much better foundation, which means less liability to breaks and leaks. It is more cleanly. The new pipe line for conveying the raw water to the filters could also be used to some extent to supply the large number of elevators coming into use, and also supply fire protection to the lake front and a part of the city, thus saving quite a large volume of filtered water, which would mean less work for the filters, and also relieve our present mains, which are none too large to supply the demands upon them. The present pumps can do the work, thus handling the water but once.

As we are now obliged to keep a man at the motor house, who could also superintend the filter, the additional cost of operating the

filter, not including interest and depreciation, need not be more than about two dollars per million gallons of filtered water.

In conclusion, your committee would express hearty approval of all the recommendations contained in Mr. Baker's report, with the possible exception of the one relating to the covering of the reservoirs. Our observation of various filter plants and the information obtained from the men in charge of them, leads us to believe that it may be possible to avoid this item of expense.

Especially worthy of note from their sanitary importance, though not actually concerned with the water supply, are Mr. Baker's suggestions regarding the inspection of milk, a subject, perhaps, next in importance to water purification, and regarding a city record, to show how many and what houses have sewer connections.

Respectfully submitted,

JOHN B. WHEELER, Chairman.

F. E. CLARK, Secretary.

F. O. SINCLAIR,

J. E. MEAGHER,

F. HENRY PARKER,

GEORGE Q. STILES.

PART I.

220 BROADWAY,

NEW YORK CITY,

August 30, 1905.

Dr. John B. Wheeler, Chairman Special Water Committee, Burlington, Vt.:

Dear Sir:—In accordance with the understanding reached by correspondence with Dr. Clark, secretary of your committee, and by my conference, late last June, with you, Mr. Sinclair and other members of your committee, I submit herewith my report upon the sanitary condition of your water supply and the methods by which it should be improved. I have entered into a much more detailed study of Burlington's sanitary condition than I expected and this, combined with delays in securing certain data from Burlington, explains the length of time it has taken me to prepare this report.

Within my personal knowledge the water supply of Burlington has been an almost constant source of anxiety to its citizens during the past twenty-three years. My first introduction to the supply was President Buckham's warning to the entering class of the University of Vermont in the fall of 1882, but I understand that the fear of the water supply began some years earlier.

Although when called upon for advice I was given to understand that you were convinced that some change in your water supply was necessary and that your chief concern was to learn what that change should be, I did not feel that I could address myself to the matter of improvements until I had satisfied myself that the present supply is really a menace to health. I had hopes that the water was not so bad as painted and these hopes were largely founded on very favorable reports regarding the changed character of the water supply and the reduction in typhoid and diarrhoeal diseases after the extension of the intake in 1894. It was with great satisfaction that I listened to Prof. Wm. T. Sedgwick's able paper, read before the convention of the New England Water Works Association held in Burlington in 1896, in which he presented most convincing proof of the wisdom of extending the intake and of the safety of the Burlington water supply at that time. It should be remembered, however, that Professor Sedgwick alluded to the probability, in case of the material growth of the city, that Burlington would have "to face once more the question of a pure water supply." He added: "Special pains must also be taken to see to it that the intake pipe is kept intact and free from leakage. The unfortunate experiences of Toronto and Buffalo with broken intake pipes afford ample warnings in this direction."

Although Burlington has increased in population and still more in the extent of its sewage system since 1896, it does not seem probable that it has yet become that "much larger city" which Professor Sedgwick had in mind. But a break or leak in the intake pipe is quite within the range of possibility and my first suggestion for the safety of the water supply of Burlington is that immediate steps be taken to ascertain the condition of the intake. While there are reasons for fearing that sewage may sometimes reach the present intake mouth, there is little positive evidence on the subject. Most of the water which has been analyzed by the State Laboratory of Hygiene has been drawn from city taps, and if the intake leaks, the analyses may indi-

cate the condition of the lake much nearer shore than the mouth of the intake.

Whatever may be the condition of your intake, however, I am forced to the conclusion that a thorough-going improvement in your water supply will soon be advisable if it is not already imperative. At the close of the main body of this report I have appended a very careful and detailed study of the sanitary condition of Burlington from 1879 to 1904, inclusive. While some of the evidence presented by this study points to a need of other sanitary reforms, mentioned later on, yet the unavoidable conclusion is that these reforms alone would not reduce to a normal figure your death rates from typhoid and diarrhoeal diseases. If then a change in your water supply is advisable, what should be its character?

The possibilities of a gravity supply of what is commonly known as naturally pure water have been discussed from time to time by those interested in Burlington. The latest and perhaps the most complete discussion of the sort was in 1889-90, when both a special committee, and your former water works superintendent, Mr. F. H. Crandall, C. E. (a classmate of mine at the University), investigated all the supposedly available gravity supplies. The State Laboratory of Hygiene co-operated in the studies then made. It was concluded that no suitable gravity supply could be obtained without making large storage reservoirs and more or less lengthy pipe lines, all at great expense. Besides the necessary outlay for construction there was the certainty that some of the stored waters would give rise to tastes and odors which, though not harmful in themselves, might be extremely annoying. In fact, the popular outcry against such tastes and odors would be far greater than against a supply containing deadly disease germs.

It is possible that all trouble from tastes and odors could now be averted by the use of copper sulphate for the prevention of algæ growths, as developed by and under suggestions from the Bureau of Plant Industry, United States Department of Agriculture, within the past two years. But successful as this method of treating reservoirs appears to have been, there are still some authorities, including the State Board of Health of Massachusetts and Ohio, who refuse to sanction it, charging that it has not yet been shown conclusively that the copper will not or may not be found in the water, and if so found that

it will not be injurious to the human system. With the arguments pro and con we need not concern ourselves, for even with the algæ growths removed from consideration the trend of modern practice is toward the purification of all water from surface sources; and if Burlington is to depend on water purification for safety there is no reason why it should abandon, and every reason why it should continue, to use Lake Champlain.

Some of the reasons for continuing the use of the lake water are:

(1) the supply is unlimited; (2) it is close at hand; (3) the mains and reservoirs are adapted to its use; (4) it is not and for years to come is not likely to be so badly polluted with sewage as to make bacterial purification difficult; (5) aside from the need of bacterial purification the lake water is generally very satisfactory in quality and rarely presents any difficulties to purification.

Two well established methods of purification are available, namely: slow sand filtration and rapid or mechanical filtration. In slow sand filtration the water to be purified is passed through large artificial beds of sand supported on gravel, after which the water is collected in underdrains beneath the gravel. The whole filter bed and collecting system rests on a water tight floor and is provided with water tight walls. Where the winters are as cold as at Burlington, filter beds must be covered to prevent interference by ice. Mechanical or rapid filters are also composed of sand resting on gravel, but have comparatively small areas and consequently high rates of filtration—hence the term rapid. The filtering material is placed in tanks of steel, wood or concrete, instead of large beds, and the tanks are usually housed. Housing is relatively easy, on account of the small areas, as compared with slow sand filters.

In slow sand filtration a film of gelatinous material forms on the surface of the filter bed and on the surface of the uppermost sand grains. By means of adhesion and of straining both dirt and bacteria are removed from the water, so that the effluent from a filter bed is clarified and is also freed of nearly all its bacterial contents. The natural habitat of typhoid and other harmful water-borne disease germs being the human body, they do not thrive in water. In fact, they are so much out of their environment in water and have such a struggle there with the harmless water bacteria that many of them succumb even when the water is not purified. It is therefore easy to

believe, with the scientists, that of the relatively small number of bacteria passing any good and well operated filter, few if any are disease germs.

Gradually the sticky coating mentioned above clogs the beds, when a thin layer of the dirty sand is scraped off and washed, to be restored at need.

The work of a mechanical filter depends very largely upon the use of sulphate of alumina or some other coagulant, applied to the water in a coagulating basin. A hydrate is formed which is a flocculent precipitate and which carries down with it the impurities in the water. Some of the precipitate and accompanying impurity is retained in the coagulating basin and some goes to the filter. A layer of coagulum and impurities is formed on the surface of the bed, and large quantities penetrate into the bed, some to great depths.

A slow sand filter works days and generally weeks before it needs washing; but owing to the more rapid rates of the mechanical filters and the chemicals used, washing once a day or oftener is necessary. This is effected by manipulating valves so as to turn the water upwards instead of downwards through the filters, and by violent stirring the sand (either with power driven rakes or with compressed air admitted from below). The dirty water flows off at the top and is wasted.

It is essential that the chemicals used in mechanical filters be proportioned to both the volume and character of the water, each of which, but particularly the volume, may vary through wide ranges. Automatic devices proportion the amount of the chemical to the volume of flow, but adjustments to correspond with the changing character of the water must be made by men in charge of the plant. Moreover, the efficacy of the coagulant depends upon its combination with other chemicals in the natural water and when these are deficient they must be supplied artificially, thus adding to the care and cost of operating the purification plant.

Mechanical filters are particularly applicable to turbid or muddy and to highly colored waters, characteristics relatively absent from Lake Champlain. This type of filters is largely used on the muddy waters of the West and South; and on some waters in the Northern and North Central States that are high in broken down vegetable mat-

ters; mechanical filters have been employed but rarely on the generally clear waters of New England and the North Atlantic States.

The consensus of opinion among engineers is that for small cities with relatively clear and colorless waters slow sand filters are preferable to mechanical, giving more uniformly reliable results under the care of ordinary workmen and foremen. Much more labor is required to operate the slow sand filters than is necessary for mechanical, since hand labor is largely required in the case of the first and but little needed in the second. Quite recently, however, improved means of removing, washing, and replacing the sand has simplified the operations of slow sand filters and reduced the cost of operation.

The generally low turbidities of your water would render cleaning at frequent intervals unnecessary. The presence of the State Laboratory of Hygiene in Burlington gives you the advantage of a close watch on the operations of a filter plant and speedy notification when the water analyses indicate that anything is going wrong. These two points (relative clearness of the water and the presence of the laboratory) are of course favorable to any system of filtration, but combined with other factors they weigh heavily in favor of slow sand filtration.

I should have no hesitation in recommending slow sand filtration, were it necessary to make an off-hand decision between the two methods, but inasmuch as certain investigations of available sites and filter sands will be required in any event, it may be deemed advisable to prepare at least rough preliminary estimates for each method. This can be done by Mr. Sinclair, in connection with the detailed recommendations as to cost estimates made a little further on.

To summarize briefly the recommendations already made and also the main conclusions from the appended review of your vital statistics and general sanitary condition:

- (1) The possibility of leaks in your intake should be investigated and if leaks are found they should, of course, be stopped.
- (2) The purification of your present supply from Lake Champlain is advised, and for that purpose slow sand filtration is recommended.
- (3) It is desirable to secure the further co-operation of the State Laboratory of Hygiene in settling more definitely (a) the quality of the lake water over and in the immediate vicinity of the intake mouth; and (b) as a basis of comparison, the normal characteristics of the

lake water at points beyond the influence of sewage pollution—either from Burlington or elsewhere.

(4) Estimates for water purification should be made, including:

(a) The cost of low lift pumps to deliver water to the filters; (b) cost of pipe connections between intake and new pumps, between new pumps and filters and between filters and present pumps; (c) cost of filters; (d) cost of a small covered clear water basin for storing filtered water before it is pumped in order to equalize variations in the rates of filtration and of pumping; (e) cost of covering your present reservoirs.

(5) Further investigation of the general sanitary conditions of the city and of the efficiency of your present health-protective work should be made to determine what besides improving the water supply can be done to reduce your general mortality rate, your death rates from diarrhoeal diseases and typhoid fever and the mortality of children under five years of age, all of which seem much too high for a city of the size and natural advantages of Burlington. One much needed line of health-protective work is a rigorous sanitary control of the milk supply. This would include the licensing of all milk dealers, frequent dairy inspection, daily sterilization of milk bottles, cans and all dairy utensils, besides many other details which cannot be mentioned here. Another important health-protective measure which should be adopted, if not already in force, is the careful investigation of each typhoid case, to determine whether it is due to the water, milk or some other food supply or has its origin outside the city. The utmost care should be taken to disinfect both the stools and urine of typhoid patients. The physicians should be urged to spare no pains to arrive at a correct diagnosis of all suspected cases of typhoid fever, "walking" or otherwise, using the Widal test wherever it promises to be of service. The importance of all measures aimed to exclude typhoid-infected excreta from the lake should be understood by laymen as well as nurses and physicians.

(6) Burlington deserves great credit for its long standing and effective water-waste preventive methods. The resulting low per capita water consumption is one of the most favorable aspects of your water supply situation, now that purification must be faced. The good work accomplished in the past and still being done should be continued without let up.

In order to keep my report proper relatively brief and directly to the main point, I have placed all statistics and all detailed discussion of them in an appendix. I bespeak for the appendix not only the careful attention which it may be expected that your committee will give to it, but also the thoughtful consideration of the medical profession and all others interested in the sanitary welfare of Burlington.

Respectfully submitted,

(Signed in duplicate.)

M. N. BAKER.

PART II.

APPENDIX TO REPORT BY M. N. BAKER ON IMPROVEMENTS IN THE WATER SUPPLY OF BURLINGTON, VT.

As an aid to an understanding of the water supply situation at Burlington both present and past, and with the hope of contributing somewhat to the data of water supply and disease, I have prepared the following review of the typhoid and some of the other vital and related statistics of Burlington. Without making apologies for any part of this appendix, further than calling attention to lack of time for carrying the investigations and conclusions further, I do nevertheless wish to ask that the matter relating to diarrhoeal diseases and to infant mortality be considered as tentative, so far as any definite relations between it and water supply are concerned. It has, however, often been suggested that there is a close relation between sewage-polluted waters and diarrhoeal diseases, and never, so far as I know, with more frequency and with more grounds for assurance than in the case of the Burlington supply. I believe the diarrhoeal mortality figures may be classed among the first, if they are not actually the first, ever compiled with anything like completeness for a long period of years in connection with a water supply study.

The statistical studies here presented cover the years 1879 to 1904, inclusive. Although my file of Burlington municipal reports extends back to the one for the fiscal year 1867-8, or about to the date of the introduction of Lake Champlain water, and although I have studied the earlier reports in detail, it would be of little service to begin these studies earlier than the calendar year 1879, which was the first full year of the registration of vital statistics under city control.

Prior to the passage of the registration ordinance, in 1878, your vital statistics were gathered in January for the year just preceding and, as has been the experience under that system elsewhere, were very incomplete. For a number of years beginning with 1879 your vital statistics probably surpassed in completeness and classification those of most cities of your size. There is reason for believing that they are still more than usually complete and well summarized, but it seems a pity that Burlington has not yet adopted the United States census classification of the causes of deaths and thus put its mortality records on a comparative basis with those of other cities. However, most of the essential facts appear to have been given for some years past, rendering a reclassification no serious matter. The foot notes to some of the accompanying tables will show the new classifications and combinations made in connection with deaths from typhoid fever and from diarrhoeal diseases.

Table I shows by years, from 1879 to 1904, inclusive, or for 26 years, your mid-year populations, total deaths and deaths per 1,000 population, and also for typhoid fever, diarrhoeal diseases, and children under five years of age the number of deaths and the death rates per 100,000 population and the percentage which the deaths from each of these diseases bears to the deaths from all causes. For typhoid fever alone an attempt has been made to include the yearly number of cases, but it was not until 1898 that the cases began to be reported with anything like apparent completeness, the deaths actually equaling or exceeding the cases in these separate years and the cases not being reported at all in years as recent as 1889 and 1890. As may be seen, this table shows great fluctuations in all mortality particulars except the death rate from all causes, which has been fairly constant, and that at a high rate for a city under such favorable natural conditions as are enjoyed at Burlington. Some reasons for this high rate, besides the water supply or other sanitary conditions, will be mentioned later.

Before proceeding further I wish to explain why I have included deaths from diarrhoeal diseases in my study and also deaths of children under five years of age. It has been usual, heretofore, to stop short with a consideration of typhoid fever as an index of water pollution and a measure of the effect of such pollution on the public health. The idea has often been expressed, however, that public water supplies

unquestionably affect the total death rate otherwise than through typhoid fever. How to measure that further influence has never yet been determined, so far as I know, but it has been suggested again and again that the large class of diseases known as diarrhoeal have their many fatalities raised or lowered by the sanitary quality of the water supply. The reasons for this belief are fitter subjects for discussion by the medical profession than by engineers, and my report bids fair to be over-long without going into such details as I might be able to set forth. It is pertinent to our inquiry, however, to remark that the prevalence of some, at least, of the diarrhoeal diseases in Burlington has been common knowledge throughout if not also without the State ever since the introduction of the public water supply and that in general new comers to Burlington suffer for a time from diarrhoea. This, as I intimated at the beginning of my report, was so well accepted a fact that for many years, at least, incoming classes of students of the University were always cautioned to drink sparingly of the lake water until they become accustomed to it.

In Professor Sedgwick's paper of 1896, already mentioned, he stated as a conclusion of a study of the Burlington water supply which had extended over a number of years, that while there had been a few moderate epidemics of typhoid fever, the prevalence of diarrhoea had been decidedly more notable. He went so far as to say:

"This has been the first case within my own experience, now somewhat extensive, in which epidemic diarrhoea in a mild form has prevailed in a community for many years, having its etiology in the consumption of impure water, as has been proved by its apparent total disappearance on a change in the source of supply. The importance of the case in the history of water-borne diseases is manifest. * * * * It would seem fair to conclude, from the moderate occurrence of typhoid fever, while diarrhoea abounded, that germs of the latter disease, more hardy than those of the former, were frequently able to survive a journey from the sewer outfall to the (old) water intake, while those of typhoid fever, if present, usually perished. In future, sanitarians will not be able, by the test of typhoid fever alone, to show that a water supply is above suspicion."

These remarks by Professor Sedgwick, combined with the other reasons already named, arouse interest in the Burlington diarrhoea statistics. Unfortunately, however, mere cases of diarrhoea are not re-

ported at Burlington or, so far as I know, in any other American city. In fact, unless serious, most of them do not come to the attention of a physician. Deaths from diarrhoea have not figured high at Burlington, at least not as indicated by the published vital statistics. This may be due to difficult even, if not to faulty classification and to variations in the classification of reporting physicians from year to year. In order to have some broader and more stable basis of comparison than is afforded by diarrhoea, or even diarrhoea and dysentery together, I have included in my Table I the whole class of diarrhoeal diseases, as used by the United States Census Bureau. The details on which depend the total for diarrhoeal diseases shown in Table I are given in Table II. I have been compelled to add two columns to the list of headings taken from the census, namely, gastro-enteritis and ulceration of the bowels. If I may venture an opinion on such a subject I would suggest that some of the entries under these two heads, under more recent diagnosis, would have swelled the typhoid fever totals, as given in Table I, for the corresponding years. The same is doubtless true of some of the other entries in Table II. In fact, I think this table as a whole is a strong argument for an entire change of base in the study of polluted water supplies and the public health, particularly in the case of the older records. But to hold more specifically to the case of Burlington, I think no impartial competent judge who is or could become familiar with the past disputes at Burlington over the relation between the public water supply and typhoid fever could study the detailed figures of typhoid fever and of diarrhoeal diseases brought together in this report without being convinced that Burlington has had far more typhoid fever than was ever reported as such and that there was far more relation between the water supply and diarrhoeal diseases than has generally been supposed.

The cholera infantum column (Table II) may be consulted with possible profit in connection with both the total deaths from diarrhoea and the infant mortality (the latter given in Table I). Some may be inclined to exclude cholera infantum from diarrhoeal diseases as are related to public water supplies, and others to connect many of the cases with impure water. The figures will be interesting to either school of opinion.

The high infant (persons under five) mortality, whether or not attributed in part to the water supply, certainly demands attention, particularly as it shows comparatively little improvement of late.

Having examined the yearly figures and their vagaries in some detail, it may lessen the resulting confusion if we smooth out the extremes by considering averages for larger periods. In order to get equal periods for comparison, and also to put by itself the year in which was made the 2½-mile extension of the water intake, the averages have been cast in the three five-year groups preceding and two similar groups following the year 1894. For our purposes the most significant columns in Table III are those relating to typhoid fever. The deaths per 100,000 from this disease rose from 27 for the five years ending with 1883, to 42 for the next five years and 44 for the years 1889-93, inclusive. The new intake was put in use some time in August, 1894, and for that calendar year the rate fell to 12. In 1895 (Table I) it dropped to 6 per 100,000, but for the five years ending with 1899 it was 16. During the period 1900-04 the rate rose to an average of 25, or nearly equal to the rate for 1879-83.

The diarrhoeal diseases, if we take both the deaths per 100,000 and the percentages of deaths from all causes into account, show an increase before and a decrease upon and after the intake extension. Deaths under five years increased in the second five-year period, dropped in the third period and fell still further in 1894; since 1894 they have risen and fallen, successively, standing for 1900-04 quite near the rate figures for 1889-93.

By way of comparison it may be noted that for the registration cities of the United States in the year 1900, according to the Twelfth U. S. Census, the diarrhoeal diseases gave an average of 156.7 deaths per 100,000; the range was from 191.7 for Rhode Island to 117.6 for Michigan cities. The corresponding rural rates were 97.2 for all the registration States; 172 for Rhode Island and 65.6 for Vermont. At Burlington the diarrhoeal death rate in 1900 was 182 and in 1904, 168.

So many other factors than water supply enter into both the diarrhoeal and the under-five-year rates, and particularly into the latter, that undue weight should not be given those rates, but on the whole there is reason for congratulation in their general continued downward tendency and also in the like progress of the general mortality or deaths from all causes. But these several declines make all the more striking the recent steady increase in the typhoid deaths per 100,000. Turning from the five-year periods back to the yearly figures, we find that the typhoid death rate per 100,000 of 36 in 1904 and of 38

in 1900 have not been exceeded in any single year since the rates of 63 and 45 in 1893 and 1892, respectively.

These high typhoid figures, both for five-year periods and for single years, raise serious questions regarding the character of your water supply. The water analyses made at the State Laboratory of Hygiene intensify those questions, while the mere fact that your sewage is being discharged directly and other sewage indirectly into the lake is sufficient to cause apprehension so long as the water is used without purification.

It is only fair to the water supply to say that milk, oysters, and some other foods liable to sewage pollution may spread typhoid; and that the common house fly is now believed to be a means of infecting food, in sections where privies exist and are accessible to flies. It should also be noted that with populations no larger and typhoid deaths no more numerous than found in Burlington a slight addition to or decrease in the number of deaths from typhoid makes large variations in yearly rates and in percentages of typhoid to total deaths. Contaminated milk from some dairy or a shipment to Burlington of contaminated oysters might not cause an epidemic of such magnitude as to lead to a discovery of the real cause of the trouble, but by adding five typhoid deaths to the list might greatly increase the typhoid death rate for a given year. Another possible factor in your typhoid fluctuations may be patients from outside Burlington admitted to the Mary Fletcher Hospital. The mention of the hospital also suggests two other institutions which in times past, and I presume at the present time, add an element to the population which may have a marked effect on the returns of deaths from both diarrhoeal diseases and children under five years of age: I refer, of course, to the two children's homes in your city, which at times have added materially to your infant population by receiving children from other parts of Vermont and therefore may explain, in part, your high infant and diarrhoeal disease mortality. It is not probable that milk and other food infection combined with the hospital and the institutions for children would fully account for your unsatisfactory typhoid and other vital statistics, though possibly lessening somewhat the reflections cast on your water supply.

Unfortunately the annual reports of your various health officers throw no light upon any of the questions raised in the last few para-

graphs. They show no investigation whatever of individual cases of and deaths from typhoid fever for the purpose of tracing and removing the source of infection. They give evidence of much concern regarding the public water supply, but of no attempt to settle its actual or assumed connection with typhoid fever, further than through water analyses. I am the more surprised at this because of the evident care and thought given to some phases of health work in Burlington during the past thirty years or so.

The lack or apparent lack of all evidence of the class just named, seems to force us back upon deductions already drawn from the data thus far presented, and upon some further details of the same general character which I will now lay before you, namely, the monthly distribution of deaths from typhoid fever and some digests of water analyses.

Table IV shows the monthly distribution of typhoid deaths from 1879 to 1904, inclusive. The total typhoid deaths for each month during the entire period are also given, and have been rearranged from greatest to least in one of the foot notes to the table. The combined Februarys have 19 of the 117 deaths occurring during the 26 years and the combined January-March quarters have 42 of the 117 deaths. The lowest combined quarterly showing is 19 for April-June. The indications are that the ice covering of the lake is conducive to a high typhoid death rate. Unfortunately the returns of cases are too incomplete, particularly in the earlier years, to be of much value.

A study of the analyses made at the State Laboratory of Hygiene and published in the yearly report of the Water Department, indicates that since 1899, when the analyses were begun, the water has frequently been of a decidedly suspicious character. Table V presents averages of some of the leading features of these analyses. The chemical figures for 1899 and 1900 are notably higher and the bacterial figures decidedly lower than those for later years; and altogether the analyses show variations not easily explained, particularly when taken in conjunction with the vital statistics. On the face of the figures the average analytical results have improved or remained about stationary, save for a slight increase in total bacteria up to and including 1904 and also a recent increase in the relative number of samples showing *Bacteria Coli Communis*, or the organism common to sewage.

A much more extended series of *B. coli* determinations than those published in the annual reports was concluded at the State Laboratory of Hygiene, in January, 1905, or after the latest date covered in the annual report for the year 1904. A summary of these daily examinations is given herewith, with proper acknowledgment in the heading, as Table VI. It will be seen that of 337 daily samples no less than 147, or 44 per cent., showed *B. coli* present; also that the percentages by months ranged from 60 in December and 57 in January, to 25 in July. Judged by generally accepted standards, these daily coli tests afford the most direct and damaging of all the recent testimony against your water supply.

As already stated, *B. coli* is an evidence of sewage contamination, and where sewage is there the typhoid fever germ may be also. The typhoid germ cannot be readily isolated from water, but the *B. coli* can be so isolated with relative ease and its presence can be determined with still greater ease. Hence the coli and not the typhoid germ is sought.

When the intake was extended it was supposed that danger from sewage contamination was removed for many years to come. To account for its so speedy recurrence is not easy, in view of all the circumstances thus far presented, unless one accepts either one or the other of the two possibilities mentioned near the beginning of this report: increase in population and in volume of sewage resulting in a wider range of sewage influence, or else leaks in the intake. I have already suggested that investigations of possible intake leaks be made at once.

As to the volume of sewage now reaching the lake and probability of its being carried to the mouth of the intake, the following is interesting, even though not conclusive, so far as actual effects are concerned: The sewer outfall is about three miles from the intake. Mr. M. O. Leighton's investigation of 1904 for the U. S. Geological Survey (Water Supply and Irrigation Paper No. 121) led him to conclude that the sewage influences are widely extended and sometimes reach the intake. But those studies were altogether too limited to serve as a basis for any final conclusions, although tending to condemn the unpurified lake water. Mr. Leighton gave no little weight to the pollution of the lake at the intake by the sewage brought down in the

Winooski river. Unquestionably this is a possible source of danger, but it appears to be far more remote than the danger from the sewage which Burlington discharges directly into the lake. This is evident on considering that from the intake to the mouth of the Winooski is $3\frac{1}{2}$ miles; from the mouth of the river to the poor farm, 25,000 feet, and to the Falls of the Winooski, 25,000 feet more. For these distances I am indebted to Mr. Sinclair, who also informs me that a small amount of crude sewage is discharged into the river from the poor farm buildings; that a small part of the population of Burlington is served by a sewer which discharges into the river below the Falls; and that Winooski is well provided with sewers, all of which discharge at or near the Falls. Winooski had a population of 3,659 in 1900. Above Winooski, Fort Ethan Allen, I am informed, discharges the sewage of 1,000 or more men into the river and above that there can be no large amount of sewage pollution until Montpelier is reached, and the direct pollution there, I should suppose, is not large.

According to Mr. Leighton's Water Supply Paper, the Winooski river has a total drain area of 395 square miles, the flow from which dilutes the sewage discharges named. As nearly all the sewage reaches the river at and above Winooski, it will be seen that before reaching the intake it must pass nearly ten miles through a relatively large, sluggish and tortuous stream and then $3\frac{1}{2}$ miles across the lake, or more than 13 miles in all. Sedimentation and other natural causes in the river and the same factors in the lake, generally acting in the latter case over a wide area and assisted by a still greater dilution, must reduce to a very low figure the usual number of sewage bacteria reaching the intake by way of the river. Among these it is probable though not certain, that the typhoid bacillus would seldom be found, as water is far from being its natural habitat and it is less hardy in water than *B. coli* and other forms.

The poor farm sewage stands much more chance than does any other conveyed by the river of reaching the intake in a dangerous condition, since it is so much nearer. Perhaps more serious still, though of this I have little information, is the rendering works on or near the lake shore opposite the intake. Dejecta from cases of typhoid fever at either the poor farm or the rendering works would certainly be a cause for uneasiness if they were allowed to get into the river or lake without previously receiving a most thorough disinfection.

Reverting now to the sewage of Burlington as discharged directly into the lake: Some idea of what this amounts to can be gained from Table VII, which shows by five-year intervals the lengths of all sewers within the city as compared with the total miles of streets and of water mains. It was not until 1895 that a third of the street mileage was provided with sewers and at the close of 1904 not half of the street mileage had sewers. The water mains have always covered a much larger percentage of the street lengths than have the sewers. Since 1895 the sewer mileage has increased by half and presumably a far larger percentage of the population is sewered than is indicated by the relation between sewer and street mileage. Lack of sewer connection records in early years makes a direct comparison of sewer and water connection impossible. All the indications are that the percentage of the total population connected with the sewers has increased much faster of late than the total population itself and that this will be the rule for some years to come. This fact may have no little bearing upon the apparently more rapid increase of pollution of the lake by sewage than was expected when the intake was extended.

I cannot refrain from saying, before leaving this general subject, that the city records ought to be perfected so as to show just how many and just what houses are connected with the sewers. Such knowledge is essential to modern health-protective work. And while mentioning this apparent defect in your city records, let me also call attention to a more vital lack in your health-protective equipment, namely, a milk ordinance, combined with dairy inspections, dairy and milk dealer licenses and other essentials to the full control of the sanitary condition of the milk supply of the city. Your milk ordinance of June, 1901, aims to guard milk consumers against tuberculosis, the dissemination of which through milk is a mooted question, and against adulteration, which is largely a question of economics rather than sanitation, but leaves the people wholly unguarded against the spread of typhoid fever, scarlet fever and diphtheria and the aggravation if not the spread of infantile diarrhoeal diseases through dirty and germ-infested milk. To this negligence I attribute no small part of your excessive infant and diarrhoeal diseases mortality and through these your general death rate as well, which latter is altogether too high for a city of the size, character and natural advantages of Burlington. It is also probable that some of your typhoid fever has been due to a lack of complete sanitary supervision of your milk supply.

TABLE I. POPULATION, TOTAL AND TYPHOID DEATHS AND OTHER VITAL STATISTICS OF BURLINGTON, VT., 1879 TO 1904, INCLUSIVE.

	Popula- tion*	Total Deaths	Deaths Per 1,000	Typhoid Fever			Deaths from diar- rheal diseases			Deaths under 5 years			
				Cases†	Deaths		Total	Per 100,000	Percent of all deaths	Total	Per 100,000 Pop.	Percent all deaths	
					Total	Per 100,000 all deaths							
1879	11,000†	212	19.3	3	2	18	.94	25	227	11.8	91	828	43
1880	11,365	207	18.2	7	3	26	1.45	30	264	14.5	96	845	46
1881	11,690	205	17.5	3	2	17	.98	19	162	9.3	91	779	44
1882	12,010	230	19.2	6	8	67	3.48	20	166	8.7	88	732	38
1883	12,335	224	18.2	1	1	8	.45	25	200	11.2	95	772	43
1884	12,655	218	17.2	20	10	79	4.59	30	237	13.7	87	688	40
1885	12,980	247	19.0	..	1	8	.40	24	185	8.9	119	911	48
1886	13,300	248	18.6	2	4	30	1.66	29	218	11.8	101	753	41
1887	13,625	270	19.9	10	4	30	1.48	33	243	12.2	118	868	44
1888	13,950	347	24.3	26	9	64	2.60	59	423	17.0	168	1,204	48
1889	14,270	233	16.3	No report	8	56	3.43	35	245	15.0	97	679	42
1890	14,590	288	19.7	No report	4	27	1.39	49	336	17.0	135	925	47
1891	14,995	255	17.0	16	4	27	1.57	25	166	9.7	66	447	26
1892	15,400	306	19.2	27	7	45	2.27	56	363	18.3	127	825	41
1893	15,805	281	17.8	30	10	63	3.56	27	171	9.6	93	595	33
1894¶	16,210	290	17.9	4	2	12	.69	35	216	12.1	94	580	32
1895	16,615	291	17.5	15	1	6	.34	21	127	7.2	112	674	38
1896	17,020	360	21.2	6	4	24	1.11	45	265	12.3	153	893	42
1897	17,425	333	19.1	7	2	12	.60	44	254	13.2	123	706	37
1898	17,830	283	15.9	32	5	28	1.79	12	68	4.2	83	465	29
1899	18,235	348	19.1	33	2	11	.59	35	192	10.1	111	608	32
1900	18,640	329	17.7	35	7	38	2.12	34	182	10.3	114	612	35
1901	19,045	326	17.2	22	5	26	1.53	34	178	10.4	123	646	38
1902	19,450	312	16.0	19	2	10	.64	25	128	7.9	114	586	37
1903	19,855	379	19.0	29	3	15	.79	30	151	7.9	116	584	31
1904	20,260	365	18.0	36	7	36	1.91	34	168	9.3	126	622	35

*Population for intercensal years computed by the U. S. Census Bureau method; that is, by arithmetic increase between census.

†The population decreased about 3,000 from 1870 to 1880; the 1879 population used is arbitrary.

‡Cases of typhoid cannot be compared with deaths since the compiler had added to the typhoid deaths given in the annual health reports all deaths reported as bilious, continued, enteric, slow and typho-malarial fever; see foot note to Table IV. Deaths from Typhoid by Month.

¶New intake in use "several months" during 1904, apparently beginning in August.

TABLE II. DEATHS FROM DIARRHOEAL DISEASES AT BURLINGTON, VT., 1879 TO 1904, INCLUSIVE.

	Cholera infantum.	Cholera morbus.	Colitis.	Diarrhoea.*	Dysentery.*	Enteritis.	Gastro- enteritis.	Ulceration of bowels.	Total.
1879	18	..	..	—5—		2	..	..	25
1880	20	..	..	—7—		3	..	..	30
1881	12	1	..	—2—		4	..	..	19
1882	7	3	1†	—4—		3	2	..	20
1883	8	..	..	—5—		12	..	..	25
1884	16	..	..	—7—		3	4	..	30
1885	13	..	..	..	1	8	2	..	24
1886	19	1	..	..	..	2	6	1	29
1887	15	4	..	..	2	4	8	..	33
1888	32	1	..	..	1	12	12	1	59
1889	13	..	9†	1	..	7	5	..	35
1890	26	..	6†	1	2	7	6	1	49
1891	14	..	3†	..	..	3	3	2	25
1892	37	2	..	3	..	6	7	1	56
1893	15	1	1†	2	1	2	5	..	27
1894	22	2	2†	..	1	4	3	1	35
1895	14	..	1†	2	2	1	1	..	21
1896	28	..	5†	5	2	4	1	..	45
1897	22	2	2†	2	1	8†	7	..	44
1898	3	..	..	3	1	2	2	1	12
1899	21	1	1†	1	..	8†	3	..	35
1900	20	1	2†	..	..	6	5	..	34
1901	21	1	3†	2	1	3	3	..	34
1902	17	..	1†	..	1	5	1	..	25
1903	17	..	3†	1	..	2	7	..	30
1904	19	..	5¶	3	..	3	4	..	34

*From 1879 to 1884, inclusive, diarrhoea and dysentery were not separately reported.

†Enterocolitis.

‡Including one intestinal colic (1887).

¶Including one entero-colitis.

TABLE III. DEATH RATES FROM ALL CAUSES AND FROM TYPHOID AND OTHER DISEASES BY FIVE-YEAR PERIODS BEFORE AND AFTER EXTENDING BURLINGTON WATER WORKS INTAKE.

	All causes per 1,000.	TYPHOID.		DIARRHOEAL.		UNDER 5 YEARS.	
		Per 100,000.	Per cent. all deaths.	Per 100,000.	Per cent. all deaths.	Per 100,000.	Per cent. all deaths.
1879—83	20.2	27	1.48	204	10.9	789	43
1883—88	20.0	42	2.11	263	13.1	891	45
1889—93	18.2	44	2.43	256	14.1	690	38
1894	17.8	12	.69	216	12.1	580	32
1895—99	18.5	16	.86	182	9.8	668	36
1900—04	17.6	25	1.40	161	9.2	609	35
1879—1904	18.4	29	1.58	208	11.2	708	38

TABLE IV. MONTHLY DISTRIBUTION OF TYPHOID MORTALITY AT BURLINGTON, VT., 1879 TO 1904, INCLUSIVE.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1879 .....	..	..	..	..	1	..	..	..	..	..	..	1	2
1880 .....	..	1	..	..	1	..	1	..	..	..	..	..	3
1881 .....	..	..	..	..	..	..	..	..	1	..	1	..	2
1882 .....	..	3	2	..	..	..	..	..	..	1	2	..	8
1883	1	..	..	..	..	..	..	..	..	..	..	..	1
1884	1	..	..	..	..	2	4	2	..	1	..	..	10
1885 .....	..	..	..	..	..	1	..	..	..	..	..	..	1
1886 .....	..	..	..	..	..	2	..	..	1	1	..	..	4
1887	2	..	..	1	..	..	..	..	..	..	..	1	4
1888	1	..	..	1	..	1	1	..	3	1	..	1	9
1889	1	2	..	1	..	..	..	1	1	1	..	1	8
1890 ..	..	1	1	..	..	..	1	..	..	..	..	1	4
1891 .....	..	3	..	..	..	..	..	..	..	..	1	..	4
1892	1	..	1	..	..	..	..	1	..	2	1	1	7
1893	1	4	2	..	1	..	..	1	1	..	..	..	10
1894 .....	..	1	..	..	..	..	..	1	..	..	..	..	2
1895 .....	..	..	..	..	..	..	1	..	..	..	..	..	1
1896 .....	..	1	..	..	..	1	1	1	..	..	..	..	4
1897 .....	..	..	..	..	..	1	1	..	..	..	..	..	2
1898	1	1	1	..	..	..	..	..	1	1	..	..	5
1899 .....	..	..	1	..	..	..	..	1	..	..	..	..	2
1900	2	2	..	..	..	..	..	..	1	1	..	1	7
1901	1	..	2	1	..	..	..	..	..	..	1	..	5
1902 .....	..	..	..	1	..	..	..	..	..	..	..	1	2
1903 .....	..	..	..	..	1	1	..	1	..	..	..	..	3
1904 .....	..	..	1	..	..	1	2	..	1	1	1	..	7
Totals.....	12	19	11	5	4	10	12	9	10	10	7	8	117

1885—1 typho-malarial fever in June.
 1886—1 bilious fever in June; 1 slow fever in September.
 1887—1 typho-malarial in May and 1 in December.
 1888—1 continued fever in April, 1 in July, 2 in September, 1 in October.
 1889—1 continued in February, 1 enteric in April.
 1890—1 continued in July; 1 typho-malarial in March and 1 in December.
 1892—1 continued in January and 1 in December; 1 enteric in October; 1 typho-malarial in August.
 1893—1 bilious in February; 1 continuous in March.
 1894—1 bilious in August.
 1896—1 continued in August; 1 typho-malarial in February and 1 in June.
 1897—1 bilious in June.
 1898—1 bilious in October.
 1899—1 bilious in August.
 1901—1 bilious in January.

The deaths classed as typhoid in the above table have been rearranged by months from the highest to lowest, as follows: Feb., 19; Jan., 12; July, 12; March, 11; June, 10; Sept., 10; Oct., 10; Aug., 9; Dec., 8; Nov., 7; April, 5; May, 4; total, 117.

By quarterly periods the grouping, from highest to lowest, is: Jan.-March, 42; July-Sept., 31; Oct.-Dec., 25; April-June, 19; total, 117. The monthly mass average is 9.75.

TABLE V. BURLINGTON WATER ANALYSES AVERAGED BY YEARS.

(Chemical results in parts per 1,000,000; bacterial, number in 1 cu. cm.)

	Number of samples.	Total.	Bacteria.		Ammonia.	
			Coll. present.	Chlorine.	Free.	Albuminoid.
1899	27	268	Not reported	1.4	.031	.141
1900	38	529	Not reported	2.3	.039	.139
1901	24	1293	7 of 24	.9	.021	.134
1902	66	617	13 of 65	1.1	.014	.115
1903	49	641	8 of 49	1.1	.011	.113
1904	50	782	13 of 49	1.0	.012	.114
First half of 1905	26	170	7 of 24	1.1	.012	.115

TABLE VI. B. COLI COMMUNIS IN DAILY SAMPLES OF WATER FROM THE BURLINGTON WATER SUPPLY, FEBRUARY, 1904, TO JANUARY, 1905, INCLUSIVE.

(Examinations of 1 c.c. of water made at the Vermont State Laboratory of Hygiene. B. H. Stone, M. D., Director and Bacteriologist; P. S. Carpenter, Assistant Bacteriologist.)

	Number of daily samples.	Percent of samples positive.		Percentages rearranged greatest to least.
February	29	34	December	60
March	31	45	January	57
April	30	36	October	53
May	29	51	May	51
June	28	51	June	51
July	28	25	March	45
August	31	31	April	36
September	16*	31	February	34
October	31	53	November	33
November	30	33	August	31
December	28	60	September	31
January	26	57	July	25
Year	337	44†	Year	44†

*Vacation taken this month.

†Percentage for year based on totals for the year and not merely an average of the monthly percentages; that is, of the 337 samples examined 147, or 44%, gave positive results.

TABLE VII. LENGTHS IN MILES OF STREETS, SEWERS, WATER MAINS, AND ALSO POPULATIONS AND WATER CONSUMPTION, BURLINGTON, VT., AT STATED INTERVALS.

	Length Streets.	Sewers.	Water mains.	Popula- tion.	<i>Average daily water consumption, gallons.</i>	
					Total.	Per capita.
1880	50*	6.14	20*	11,365	600,000	53
1885	....	8.54	28.7†	12,980	621,812	48
1890	53	14.07	30.4	14,590	756,401	52
1895	54.9	18.76	35.7	16,615	888,083	53
1900	55.5	23.91	38.0	18,640	857,250	46
1904	56.6†	27.50	40.0‡	20,260	987,158	49

*In 1882; not reported in 1880.

†Paved and macadamized, 22.1 miles; graveled, 17.1 miles.

‡Not including pipe under 4 inches in diameter, which was 5.8 miles in 1885 and 4.3 in 1904.

New reservoir put in use in December, 1888.

Main outlet sewer extended to dock during "season" of 1894.

220 BROADWAY,
NEW YORK CITY,

September 8, 1905.

Mr. F. E. Clark, Secretary, Special Committee on Water Supply, Burlington, Vt.:

Dear Sir:—Your letter of September 7 has been received and I will immediately answer the inquiries you make.

There is no system of sewage purification in practical use which can be relied upon to so purify sewage as to warrant its discharge into drinking water.

I do not know what the conditions are which you mention as making it possible that it would seem best to install a mechanical filter plant. In general, however, I should not recommend the adoption of any specific system of mechanical filtration. If mechanical filtration is to be adopted, plans and specifications should be prepared and competitive bids received, just as in the case of slow sand filtration. There are no controlling patents on mechanical filtration and you need an engineer to protect your interests, even though a mechanical filtration contract should be awarded to a company.

It is considered essential to cover any and all reservoirs used to store filtered water, since such water is particularly liable, when exposed to the sun, to give rise to vegetable growths which impart bad tastes and odors to the water.

I shall be glad to see you and other members of the committee during their trip to New York next week to attend the meeting of the New England Water Works Association and to inspect water and sewage purification plants.

Yours truly,

M. N. BAKER.

FORTIETH ANNUAL REPORT
OF THE
WATER DEPARTMENT
OF THE
CITY OF BURLINGTON, VT.
AND OF THE
WATER COMMISSIONERS.

The Eighteenth

December 31, 1906

BURLINGTON:
FREE PRESS PRINTING CO.,
PRINTERS, BINDERS, STATIONERS.
1907.

BOARD OF WATER COMMISSIONERS.

T. F. CONLON, Chairman,	(Term expires 1907).
G. W. KELLEY,	(Term expires 1908).
J. E. LANOU,	(Term expires 1909).

OFFICERS.

FRANK O. SINCLAIR, C. E., Superintendent.
Miss KATHARINE M. McCAFFREY, Registrar.
Miss J. PEARL TEACHOUT, Office Assistant.
JAMES J. CANNON, Engineer at Pumping Station.
WILLIAM CASSIDY, Foreman.
OSCAR HEININGER, Chief Inspector.

EIGHTEENTH ANNUAL REPORT
OF THE
WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

Gentlemen:—As required by ordinance, the Board of Water Commissioners herewith submit their report for the year ending December 31, 1906:

The receipts from water rates for the year have been \$45,561.98. The unpaid water bills, which are twenty-two in number, amount to \$107.73. No places are off for non-payment.

The pumpage for the year is 368,257,775 gallons, a decrease from last year of 17,184,925 gallons.

A deposit to the sinking fund of \$14,674.47 has been made, which is \$12,418.90 in excess of the amount required by the city charter.

On July 1, 1906, we paid \$60,000.00 of water bonds from our sinking fund, using the whole amount of our sinking fund at that date.

The bonded debt of the city on account of this department is as follows:

Four per cent. bonds due in 1914.....	\$ 30,000 00
Four per cent. bonds due in 1919.....	58,000 00
Four per cent. bonds due in 1926.....	100,000 00

Total.....	\$188,000 00
------------	--------------

The appropriation for 1906 has been sufficient to meet all the expenses of the department, including interest, \$1,370.52 for construction, and deposit to the sinking fund of \$12,418.90 in excess of the 5 per cent. of the appropriation required by ordinance.

The biological and chemical examinations made at the laboratory of the State Board of Health have been continued, and are tabulated in the accompanying report of the Superintendent.

Respectfully submitted,

THOS. F. CONLON,	} Water
G. W. KELLEY,	
J. E. LANOU,	

} Commissioners.

FORTIETH ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS.

To the Honorable Board of Water Commissioners of the City of Burlington, Vt.:

Gentlemen:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1906, as taken from the books of the office:

RECEIPTS.

From L. C. Grant, City Treasurer:—

Transfer to sinking fund required.....	\$ 2,255 57
Transfer to construction required.....	1,370 52
Balance appropriation for current expenses....	41,485 33

Total amount of appropriation	\$45,111 42
Amount received for material and labor.....	947 41

Total receipts from City Treasurer.....\$46,058 83

DISBURSEMENTS.

Construction:—

Pay rolls, services	\$ 544 73
Buildings	416 51
Pay rolls, mains	166 95
Material for services	130 20
Pipe	102 18
Lead and gates.....	9 95

\$ 1,370 52

WATER DEPARTMENT.

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MAINTENANCE.**Current:—**

Pay rolls	\$3,184 84
Salary of Superintendent	1,500 00
Reservoir cleaning and repairs	856 24
Salary of Registrar	600 00
Pipe and castings	586 63
Stable expenses	394 63
Material for management and repairs.....	353 67
Tank cleaning and repairs	267 20
Hydrant inspection and repairs	260 22
Adding machine	250 00
Gates	233 64
Printing, advertising and postage	151 40
Office expenses	146 43
Telephone rent	144 23
T. F. Conlon, Water Commissioner.....	100 00
J. E. Lanou, Water Commissioner.....	100 00
G. W. Kelley, Water Commissioner.....	100 00
Repair of tools	45 75
Insurance	38 34
Fuel and light	26 20
Damages	11 68
Plumbing bills	4 85
Sprinkling tax	4 62

\$9,360 57**INTEREST.**

Interest on debt	\$8,720 00
------------------------	------------

PUMPING.**Low service station:—**

Pay rolls	\$3,032 43
Fuel	4,039 04
Oil and packing	198 54
Repairs to machinery	131 66
Repairs to tools and supplies.....	75 64
Buildings and grounds	34 35

\$7,511 66

High service station:—

Building and grounds\$187 55

Fuel and light 32 65

\$220 20

Steam pump:—

Repairs and care\$206 95

Fuel 27 37

\$234 32

Motor:—

Care\$349 59

Repairs 47 14

Supplies 5 58

\$402 31

\$856 83

\$8,368 49

METERS.

Pay rolls\$2,404 15

Meters 1,083 56

Material for repairs 66 89

Supplies 10 18

\$3,564 78

Total maintenance.....\$31,384 36

TRANSFERS.

To sinking fund, 5 per cent. required by charter..\$ 2,255 57

Sinking fund, surplus funds 12,418 90

Total transfers\$14,674 47

Total disbursements 46,058 83

RECAPITULATION.

RECEIPTS.

From L. C. Grant, City Treasurer.....\$46,058 83

WATER DEPARTMENT.

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DISBURSEMENTS.

Maintenance:—

Current	\$ 9,360 57
Pumping	8,368 49
Meters	3,564 78

\$21,293 84

Interest	8,720 00
----------------	----------

Total maintenance	\$30,013 84
Transfers	14,674 47
Construction	1,370 52

Total disbursements.....\$46,058 83

WATER TAX COLLECTIONS.

RECEIPTS.

Schedule rates	\$ 6,641 81
Meter rates	38,920 17

Total receipts.....\$45,561 98

DISBURSEMENTS.

L. C. Grant, City Treasurer.....	\$45,561 98
----------------------------------	-------------

UNPAID WATER RATES.

Meter rates, thirteen	\$43 69
Schedule rates, nine	64 04

Total unpaid water rates forward to 1907.....\$ 107 73

AUDITORS' STATEMENT.

We, the undersigned, have examined the books and vouchers for the year 1906 in the office of the Superintendent of the City Water Works, and find them correct.

We also find that the provisions of the water ordinance, relative to collection of water rates, discount, penalty, etc., have been fairly and impartially administered.

T. A. DELANY, THOMAS FAILEY, HARRY H. ROSENBERG,	}	Auditors.
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STATEMENT OF ASSESSMENTS AND CURRENT EXPENDITURES

For the Year Ending Dec. 31, 1906.

The paid assessments of this statement are the receipts for the year less whatever portion of the same was assessed previous to Jan. 1, 1906. The unpaid are the unpaid of Jan. 1, 1907, less whatever portion of the same are of more than one year's standing:

ASSESSMENTS.	DISBURSEMENTS.
<p style="text-align: center;"><i>Paid.</i></p> <p>Meter rates, \$38,920 17</p> <p>Schedule rates, 6,641 81</p> <hr style="width: 20%; margin-left: 0;"/> <p style="text-align: right;">\$45,561 98</p> <p>Material & labor, 947 41</p> <hr style="width: 20%; margin-left: 0;"/> <p style="text-align: right;">\$46,509 39</p> <p style="text-align: center;"><i>Unpaid.</i></p> <p>Meter rates, \$ 43 69</p> <p>Schedule rates, 64 04</p> <p>Material & labor, 947 74</p> <hr style="width: 20%; margin-left: 0;"/> <p style="text-align: right;">\$ 1,082 47</p> <hr style="width: 20%; margin-left: 0;"/> <p style="text-align: right;">\$47,591 86</p>	<p>Interest, \$ 8,720 00</p> <p>Current, \$9,360 57</p> <p>Pumping, 8,368 49</p> <p>Meters, 3,564 78</p> <hr style="width: 20%; margin-left: 0;"/> <p style="text-align: right;">\$21,293 84</p> <hr style="width: 20%; margin-left: 0;"/> <p style="text-align: right;">\$30,013 84</p> <p>Excess of assessments over disbursements for the year 1906, \$17,578 02</p> <hr style="width: 20%; margin-left: 0;"/> <p style="text-align: right;">\$47,591 86</p>

WATER PUMPED.

1906.	Gallons.
January	25,531,300
February	26,729,350
March	28,667,825
April	25,909,800
May	28,873,775

WATER DEPARTMENT.

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June	34,680,450
July	38,428,250
August	38,115,175
September	34,341,700
October	30,820,625
November	26,995,400
December	29,164,125

Total 1906.....	368,257,775
Total 1905.....	385,442,700

Decrease in 1906.....	17,184,925
Daily average in 1906	1,008,925
Daily average in 1905	1,056,008

SERVICES.

There have been added sixty-two services of the following sizes:

Fifty-four	$\frac{1}{2}$ inch.
Five	$\frac{3}{4}$ inch.
One	1 inch.
One	1 $\frac{1}{4}$ inch.
One	2 inch.

Three services have been discontinued during the year.

HYDRANTS.

There have been no new hydrants set.

Total number of public hydrants.....	181
Total number of private hydrants.....	37

Total.....	218
------------	-----

SUPPLY PIPE.

There has been no new supply pipe laid.

Total length of supply pipe now in use....25,408 feet.

MAINS.

New mains have been laid as follows:

With four inch cast iron pipe.—

Summit street, northerly..... 120 feet.

With six inch cast iron pipe.—

Henry street, northerly 120 feet.

LENGTH OF PIPE NOW IN USE.

Cement	22,245 feet.	About 4 miles.
Cast iron	188,198 feet.	About 36 miles.
<hr/>		
Total.....	210,443 feet.	About 40 miles.

GATES.

There have been no new gates set.

Total now in use 679

SMALL STOP-GATES.

There have been no small stop-gates added.

Total number of small stop-gates now in use.... 70

SINKING FUND.

Deposits to this fund have been made with the City Treasurer as follows:

Aug. 13, 1906, surplus funds.....	\$ 2,255 57
Dec. 31, 1906, surplus funds.....	12,418 90
<hr/>	
Total	\$14,674 47

HIGH SERVICE.

The consumption on the high service as indicated by the pumping records of that station, was nearly sixteen million gallons, or about 4 per cent. of that of the low service. Of this amount, about 64 per cent. was measured to consumers through meters; 5 per cent. was the estimated loss in the motor; 12 per cent. was used at the motor valves; about 9 per cent. returned to the reservoir by way of the overflow pipe, and 10 per cent. remains unaccounted for.

About 81 per cent. of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 19 per cent. by the auxiliary steam pump.

Average daily consumption..... 5,796 cubic feet.

Average daily consumption per tap.... 82 cubic feet.

METERS.

There are now in use 2,983 meters, an increase of 119 over last year. Of the water pumped, about 55 per cent. has passed through meters yielding about 85 per cent. of the revenue.

The present pumps are old, inefficient and liable to fail at any time. The fuel consumption with them is very high. New pumps would show a saving in cost of coal of 30 per cent. or more.

The liability of failure of one or both of the pumps has reached a point where we can no longer put off some action that will remove the danger which threatens the city in case of such failure, without rendering ourselves liable to censure.

On the ground then of economy and safety, I would recommend and hope to see installed soon a modern pumping plant.

Respectfully submitted,

FRANK O. SINCLAIR,

Superintendent.

SUMMARY OF STATISTICS

For the Year Ending December 31, 1906.

IN FORM RECOMMENDED BY THE

NEW ENGLAND WATER WORKS.
ASSOCIATION.

Burlington City Water Works.
Burlington, Chittenden County, Vermont.

GENERAL STATISTICS.

Population by census of 1900,—18,640.

Date of construction, 1867-8.

By whom owned, City.

Source of supply, Lake Champlain.

Mode of supply (whether gravity or pumping), pumping.

PUMPING STATISTICS.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel used.

{	<ol style="list-style-type: none"> a. Kind, bituminous. b. Brand of coal. c. Average price of coal per gross ton, delivered, \$3.50. d. Percentage of ash. e. Wood, price per cord, none used.
---	---
3. Coal consumed for the year, 2,864,600 pounds.
4. (Pounds of wood consumed) \div 3 = equivalent amount of coal.
- 4a. Amount of other fuel used, none.
5. Total equivalent coal consumed for the year = (3) + (4), 2,864,600 pounds.
6. Total pumpage for the year, 368,257,775 gallons, with no allowance for slip.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
9. Number of gallons pumped per pound of equivalent coal (5), 128.55 gallons.

WATER DEPARTMENT.

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$$10. \text{ Duty} = \frac{368,257,775 (6) \times 8.34 \times 100 \times 316 (8)}{2,864,600 (5)} \left. \vphantom{\frac{368,257,775 (6) \times 8.34 \times 100 \times 316 (8)}{2,864,600 (5)}} \right\} = 33,237,044.$$

Cost of pumping figured on pumping station expenses, viz., \$8,489.38.

11. Per million gallons pumped, \$23.02.

12. Per million gallons raised one foot (dynamic), \$0.073.

FINANCIAL STATISTICS.

RECEIPTS.	EXPENDITURES.
Balance brought forward:	Water Works maintenance:
(a) From ordinary (main- tenance) receipts, \$45,111 42	AA. Operation (manage- ment and repairs), \$22,664 36
(b) From extraordinary re- ceipts (bonds, etc.), 947 41	BB. Special,
Total, \$46,058 83	CC. Total maintenance, 31,384 36
From water rates:	DD. Interest on bonds, 8,720 00
A. Fixture rates, \$ 6,641 81	EE. Payment of bonds, 60,000 00
B. Meter rates, 38,920 17	FF. Sinking funds, 14,674 47
C. Total from consumers, 45,561 98	Water Works construction:
D. For hydrants, 620 00	GG. Extension of mains, 279 08
E. Fountains and parks, 617 69	HH. Extension of services, 674 93
F. For street watering, 1,687 12	II. Extension of meters, 1,083 56
G. For public buildings, 207 26	JJ. Special,
H. For miscellaneous uses, 45,111 42	KK. Total construction, 1,370 52
I. General appropriation,	LL. Unclassified expenses,
J. Total from mun. debts,	MM. Balance,
K. From tax levy,	(aa) Ordinary,
L. From bond issue,	(bb) Extraordinary,
M. From other sources, 947 41	Total balance,
N. Total, \$46,509 39	N. Total, \$.....

Disposition of balance.—

O. Net cost of works to date.....	\$491,446 59
P. Bonded debt at date	138,000 00
Q. Value of sinking fund at date.....	14,674 47
R. Average rate of interest.....	4 per cent.

STATISTICS OF CONSUMPTION OF WATER.

1. Estimated total population at date.....	20,500
2. Estimated population on lines of pipe.....	20,100
3. Estimated population supplied	20,000
4. Total consumption for the year.....	368,257,775 gallons
5. Passed through meters	203,556,600 gallons
6. Percentage of consumption metered	55 per cent.

7. Average daily consumption	1,008,925 gallons
8. Gallons per day to each inhabitant.....	49 gallons
9. Gallons per day to each consumer.....	50 gallons
10. Gallons per day to each tap	247 gallons
11. Cost of supplying water, per million gallons figured on total maintenance (item CC)	\$61 54
12. Total cost of supplying water, per million gallons, fig- ured on total maintenance + interest on bonds.....	\$85 22

STATISTICS RELATING TO DISTRIBUTION SYSTEM.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Kind of pipe, galvanized, cast iron and lead.
2. Sizes, from 4 to 30 inch.	17. Sizes, ½ to 6 inches.
3. Extended 240 feet during the year.	18. Extended, 1,550 feet.
4. Discontinued 0 feet during the year.	19. Discontinued, 125 feet.
5. Total now in use, about 40 miles.	20. Total now in use, 19.92 miles.
6. Cost of repairs per mile, \$——.	21. Number of service taps added during the year, 62.
7. Number of leaks per mile, —.	22. Number now in use, 3,696.
8. Length of pipes less than 4 inches in diameter, 4.8 miles.	23. Average length of service, 25 feet.
9. Number of hydrants added during the year (public and private), —.	24. Average cost of service for the year, \$13.50.
10. Number hydrants (public and private) now in use, 218.	25. Number of meters added, 119.
11. Number of stop gates added during the year, —.	26. Number now in use, 2,983.
12. Number of stop gates now in use, 679.	27. Percentage of services metered, 81 per cent.
13. Number of stop gates smaller than 4 inch, 70.	28. Percentage of receipts from metered water (B÷C), 85%.
14. Number of blow-offs, 14.	29. Number of motors and elevators added, 2.
15. Range of pressure on mains, 70 to 85 pounds average.	30. Number now in use, 41.

PARTS IN 1,000,000.																
ODOE.										RESIDUE.		AMMONIA.				
Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	Cold.	Hot.	Total solids.	Loss on ignition.	Fixed solids.	Free.	Albuminoid.	Chlorine.	Hardness.	Nitrogen as nitrates.	Nitrogen as nitrites.
38300	1-3-06	1-3-06	Slight	Vy slight	15	2v	2v	..	..	..	.022	.110	1.0	47.1	.170	.000
38421	1-10-06	1-10-06	Slight	Vy slight	13	0	0	..	..	..	.002	.100	1.2	48.6	.200	.000
38539	1-17-06	1-17-06	Slight	Vy slight	13	1v	1v	..	..	..	.024	.096	1.2	51.4	.200	.000
38683	1-24-06	1-24-06	Slight	Vy slight	12	3v	3v	..	..	..	.006	.114	1.1	44.8	.140	.000
38709	1-25-06	1-25-06	Decided	Considerable	22	2e	2e	83	17	86	.032	.128	1.0	50.	.240	.000
38708	1-31-06	1-31-06	Vy slight	Vy slight	13	2v	2v	..	..	..	.006	.116	1.0	50.	.220	.000
38838	2-3-06	2-3-06	None	Slight	13	0	0	..	..	..	.004	.098	1.0	45.7	.220	.000
38977	2-14-06	2-14-06	Vy slight	Vy slight	16	1v	1v	..	..	..	.022	.116	1.0	47.1	.200	.000
39002	3-22-06	3-22-06	None	Vy slight	22	1v	1v	..	..	..	.014	.130	1.1	45.7	.210	.000
39330	3-1-06	3-1-06	Vy slight	Vy slight	13	2v	2v	..	..	..	.028	.136	1.2	45.7	.240	.000
39833	3-29-06	3-29-06	Distinct	Vy slight	10	1v	1v	..	..	..	.016	.114	1.2	47.1	.230	.000
40078	4-12-06	4-12-06	Slight	Vy slight	16	0	0	..	..	..	.028	.106	1.0	47.1	.150	.000
39935	4-5-06	4-5-06	Distinct	Slight	10	2v	2v	..	..	..	.008	.122	1.1	47.1	.240	.000
40220	4-18-06	4-18-06	Distinct	Vy slight	10	0	0	..	..	..	.018	.148	1.0	47.1	.180	.000
40510	5-3-06	5-3-06	Slight	Slight	11	2v	2v	..	..	..	.028	.148	1.0	47.1	.150	.000
40873	5-10-06	5-10-06	Distinct	Slight	18	3v	3v	..	..	..	.048	.190	0.9	45.7	.200	.000
40358	4-26-06	4-26-06	Slight	Slight	16	2e	2e	..	..	..	.008	.100	1.1	47.1	.200	.000
41041	5-31-06	5-31-06	Vy slight	Vy slight	18	3a	3a	..	..	..	.008	.124	1.1	52.9	.160	.000
41151	6-7-06	6-7-06	Slight	Slight	12	2v	2v	72	20	52	.010	.136	1.2	47.1	.170	.000
40946	5-24-06	5-24-06	Distinct	Vy slight	14	1v	1v	..	..	..	.004	.128	0.9	51.4	.120	.000
40820	5-17-06	5-17-06	Distinct	Slight	16	2v	2v	..	..	..	.020	.128	1.2	50.0	.180	.000
41456	6-28-06	6-28-06	Distinct	Slight	15	2v	2v	..	..	..	.032	.116	1.0	50.	.160	.000

SOURCE.	BACTERIA.				Microscopically.	REMARKS.
	Bacteria in 1 c.c. at room temp.	B. Coll.	B. Coll per c.c. at blood temp.	Ratio of liq. to non-liq. calories.		
Tap at Laboratory	50	Present	14	..	Negative	Shows presence of sewage bacteria.
"	40	Absent	4	..	Negative	Chlorine high; usual condition.
"	100	Absent	..	..	Negative	Chlorine and free ammonia a trifle higher than usual, due prob-
"	50	Absent	..	..	Negative	ably to high water in river.
"	Liquidified	Present	140	..	Negative	Usual condition; high chlorine.
"	200	Absent	..	..	Negative	Shows evidence of pollution.
"	Liquidified	Present	40	..	Negative	Normal condition; chlorine high.
"	50	Absent	6	..	Negative	Shows evidence of pollution.
"	50	Present	18	..	Negative	Usual condition; high chlorine.
"	Liquidified	Absent	10	50%	Negative	Chlorine and color too high; sewage bacteria present.
"	100	Absent	40	..	Negative	Usual condition; chlorine above normal.
"	100	Absent	40	..	Negative	Normal condition; chlorine higher than normal from this loc'y.
"	100	Absent	20	..	Negative	Usual condition; high chlorine.
"	200	Absent	40	25%	Negative	Usual condition; chlorine high.
"	80	Absent	6	..	Negative	Chlorine higher than normal.
"	70	Absent	..	..	Negative	Usual condition; high chlorine.
"	120	4 per c.	80	..	Negative	This specimen shows evidence of contamination.
"	100	Absent	..	..	Negative	Chlorine higher than usual; shows bacillus coli communis (sew-
"	150	Absent	..	..	Negative	lage bacteria).
"	120	Present	80	..	Negative	Shows presence of bacillus coli communis.
"	50	Absent	..	..	Negative	Chlorine high as usual.
"	140	Absent	..	..	Negative	Shows presence of bacillus coli communis.
"						High chlorine.
"						Usual condition; chlorine above normal.

PARTS IN 1,000,000.																		
Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	Cold.	Hot.	ODOR.										
								Total solids.	Loss on ignition.	Fixed solids.	Free.	Albuminoid.	Chlorine.	Hardness.	Nitrogen as nitrates.	Nitrogen as nitrates.		
41345	6-21-06	6-21-06	Distinct	V. y slight	11	42	42	..	..	..	.008	.951	..	..	..	..	..	..
41264	6-15-06	6-15-06	V. y slight	V. y slight	11	42	42	..	..	..	.022	.142	..	..	..	..	..	..
42068	8-3-06	8-3-06	Slight	Slight	15	42	0	70	34	36	.018	.130	..	..	..	..	..	..
41938	7-28-06	7-28-06	Slight	Slight	15	42	0	80	30	35	.016	.136	..	..	..	..	..	..
42381	8-20-06	8-20-06	Slight	Slight	15	42	0	61	21	40	.008	.138	..	..	..	..	..	..
42690	9-6-06	9-6-06	V. y slight	V. y slight	15	42	42	64	22	42	.018	.150	..	..	..	..	..	..
43043	9-26-06	9-26-06	V. y slight	V. y slight	15	42	42	78	22	42	.022	.178	..	..	..	..	..	..
43701	10-25-06	10-25-06	V. y slight	V. y slight	15	42	0	64	..	96	.022	.124	..	..	..	..	..	..
43965	11-3-06	11-3-06	V. y slight	V. y slight	15	42	0	64	..	96	.022	.164	..	..	..	..	..	..
44109	11-9-06	11-9-06	None	V. y slight	15	42	0	90	..	96	.024	.172	..	..	..	..	..	..
44307	11-16-06	11-16-06	None	V. y slight	15	42	0	88	..	96	.022	.162	..	..	..	..	..	..
44591	11-27-06	11-27-06	None	V. y slight	12	42	0	70	..	96	.024	.162	..	..	..	..	..	..
44835	12-8-06	12-8-06	V. y slight	V. y slight	12	42	0	70	..	96	.010	.158	..	..	..	..	..	..
45095	12-24-06	12-24-06	V. y slight	V. y slight	10	42	42	95	..	96	.022	.156	..	..	..	..	..	..

SOURCE.	BACTERIA.				REMARKS.	
	Bacteria in 1 c.c. at room temp.	B. Coll.	B. Coll per c.c. at blood temp.			Microscopically.
			Ratio of liq. to non-liq g calories.			
Tap at Laboratory	200	Absent	9	Negative	Usual condition ; chlorine higher than normal. Usual condition ; chlorine higher than normal. Sewage pollution indicated by presence of bacillus coli com- munis with high chlorine.	
" " "	250	Absent	20	Negative		
" " "	100	Present	8	Negative		
" " "	220	Absent	2	Negative	Usual condition.	
" " "	200	Present	..	Negative	Polluted water.	
" " "	100	Present	..	Negative	High chlorine.	
" " "	500	Absent	8	Negative	Usual condition ; chlorine above normal.	
" " "	100	Absent	Liq.	Negative	Usual condition.	
" " "	100	Absent	Abs't	Negative	Usual condition.	
" " "	100	Absent	..	Negative	Usual condition.	
" " "	120	Absent	2	Negative	Usual condition.	
" " "	400	Absent	50	.....	Usual condition.
" " "	200	Present	16	.....	Usual condition.
" " "	350	Present	16	.....	Bacillus coli communis present.
" " "	830	Present	14	.....	Shows pollution.

FORTY-FIRST ANNUAL REPORT

OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.

AND OF THE

WATER COMMISSIONERS

THE NINETEENTH.

DECEMBER 31, 1907.

FORTY-FIRST ANNUAL REPORT

OF THE

WATER DEPARTMENT

OF THE

CITY OF BURLINGTON, VT.

AND OF THE

WATER COMMISSIONERS

THE NINETEENTH.

DECEMBER 31, 1907.

BURLINGTON :
FREE PRESS PRINTING CO.
PRINTERS, BINDERS, STATIONERS.
1908.

COMPLIMENTS OF
Burlington Water Department.
J. FRANK KIDDER, Supt.
PLEASE EXCHANGE.

BOARD OF WATER COMMISSIONERS.

G. W. KELLEY, Chairman, (Term expires 1908).

J. E. LANOU, (Term expires 1909).

A. H. RUTTER, (Term expires 1910).

OFFICERS.

J. FRANK KIDDER, Superintendent.

Miss KATHARINE M. McCAFFREY, Registrar.

Miss M. AGNES McCAFFREY, Office Assistant.

JAMES J. CANNON, Engineer at Pumping Station.

WILLIAM CASSIDY, Foreman.

OSCAR HEININGER, Chief Inspector.

NINETEENTH ANNUAL REPORT

OF THE

WATER COMMISSIONERS.

To the Honorable, the City Council, City of Burlington:

GENTLEMEN:—As required by ordinance, the Board of Water Commissioners herewith submit their report for the year ending December 31, 1907.

The receipts from water rates for the year have been \$47,358.52. The unpaid water bills, which are ninety-eight in number, amount to \$424.84. No places are off for non-payment.

The pumpage for the year is 380,986,000 gallons, an increase over last year of 12,728,225 gallons.

A deposit to the sinking fund of \$12,899.42 has been made, which is \$10,621.32 in excess of the amount required by the city charter. The value of sinking fund at date is \$27,573.89.

The bonded debt of the city on account of this department is as follows:

Four per cent. bonds, due in 1914.....	\$ 30,000 00
Four per cent. bonds, due in 1919.....	58,000 00
Four per cent. bonds, due in 1926.....	100,000 00

Total.....	\$188,000.00
------------	--------------

The appropriation for 1907 has been sufficient to meet all expenses of the department, including interest, \$7,092.12 for construction, and deposit to the sinking fund of \$10,621.32 in excess of the 5 per cent. of the appropriation required by ordinance.

The biological and chemical examinations made at the laboratory of the State Board of Health have been continued, and are tabulated in the accompanying report of the Superintendent.

Respectfully submitted,

G. W. KELLEY,	}	Water
J. E. LANOU,		Com-
ALBERT H. RUTTER,		missioners.

FORTY-FIRST ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS.

To the Honorable Board of Water Commissioners of the City of Burlington, Vt.:

GENTLEMEN:—The following is a statement of the receipts and disbursements of the Burlington City Water Works for the year ending December 31, 1907, as taken from the books of the office:

RECEIPTS.

From L. C. Grant, City Treasurer:—

Transfer to sinking fund required.....	\$ 2,278 10
Transfer to construction required.....	7,092 12
Balance appropriation for current expenses.....	36,191 76

Total amount of appropriation.....	\$45,561 98
------------------------------------	-------------

Amount received for material and labor.....	2,663 97
---	----------

Total receipts from City Treasurer.....	\$48,225 95
---	-------------

DISBURSEMENTS.

Construction:—

Pay-roll	\$ 1,749 31
Pipe	1,818 57
Hydrants and setting	979 00
New services	718 32
St. Louis St., 6"	489 34
North Bend St., 6"	402 80

WATER DEPARTMENT.

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South Winooski Ave. extension, 6"	306 06
Main St. (galvanized), 2"	256 83
Repairs to tools and supplies	148 77
Charles St., 2"	108 07
Material for service	94 05
Buildings	21 00

\$7,092 12

MAINTENANCE.

Current:—

Pay-rolls	\$1,151 55
Salary of Superintendent, J. Frank Kidder.....	666 64
Salary of Registrar	660 00
Repairing leaks caused by breakage, bad joints, and elec.	651 45
Stable expenses	500 12
Salary of Superintendent, Frank O. Sinclair.....	500 00
Rent and sprinkling tax	404 62
Horse and wagon	375 00
Lowering services	372 27
Printing, advertising and postage	233 07
Thawing frozen services	168 00
Changing pipe at filter grounds	165 73
Hydrant inspection and repairs	160 96
Office expenses	160 30
Material for management and repairs	154 28
Reservoir cleaning and repairs	144 56
Fuel and light	143 63
Damages	125 90
Telephone rent	125 12
Testing and cleaning intake	100 00
Insurance	74 36
T. F. Conlon, Water Commissioner	33 33.
J. E. Lanou, Water Commissioner	33 33
G. W. Kelley, Water Commissioner	33 33
Plumbing bills	11 81
Repair of tools	7 06

\$7,156 42

CITY OF BURLINGTON.

INTEREST.	
Interest on debt	\$7,520 00

PUMPING.

Low service station:—

Pay-rolls	\$3,255 16
Fuel	4,724 02
Buildings and grounds	428 84
Repairs to machinery	248 34
Oil and packing	207 27
Repairs to tools and supplies.....	101 47

High Service station:—

Care	\$386 46	\$8,965 10
Buildings and grounds	86 18	
Fuel and light	2 42	
	<hr/> \$425 01	

Steam pump:—

Repairs and care	\$ 13 79
Fuel	27 00
	<hr/> \$ 40 79

Motor:—

Care	\$308 38
Repairs	54 73
Supplies	1 50
	<hr/> \$364 61
	<hr/> \$880 41

METERS.

Pay-rolls	\$2,334 20	\$9,795 51
Meters	1,151 24	
Material for repairs	255 29	
Supplies	21 75	
	<hr/> \$ 3,762 48	

Total maintenance	\$28,234 41
Construction	7,092 12

Total expenditure\$35,326 53

WATER DEPARTMENT.

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TRANSFERS.

To sinking fund, 5 per cent. required by charter..	\$ 2,278 10
Sinking fund, surplus funds	10,621 32
	<hr/>
Total transfers	\$12,899 42
Total disbursements	48,225 95

RECAPITULATION.**RECEIPTS.**

From L. C. Grant, City Treasurer.....	\$48,225 95
---------------------------------------	-------------

DISBURSEMENTS.

<i>Maintenance:—</i>	
Current	\$ 7,156 42
Pumping	9,795 51
Meters	3,762 48
	<hr/>
	\$20,714 41
Interest	7,520 00
	<hr/>
Total maintenance	\$28,234 41
Transfers	12,899 42
Construction	7,092 12
	<hr/>
Total disbursements.....	\$48,225 95

STATEMENT OF RECEIPTS AND DISBURSEMENTS.**CASH RECEIPTS.**

Meter assessments	\$41,109 14
Schedule assessments	6,249 08
	<hr/>
	\$47,358 52
Material and labor	2,663 97
	<hr/>
Total	\$50,022 49
Appropriation	48,225 95
	<hr/>
Surplus	\$ 1,796 54

CASH DISBURSEMENTS.	
Appropriation	\$48,225 95
<i>Maintenance:—</i>	
Current	\$ 7,156 42
Pumping	9,795 51
Meters	3,762 48
	<hr/>
	\$20,714 41
Construction	7,092 12
Sinking fund, 5 per cent. of 1906 receipts	2,278 10
Interest on water bonds	7,520 00
	<hr/>
Total.....	\$37,604 63
	<hr/>
Surplus	\$10,621 32
	<hr/>
Total surplus.....	\$12,417 86
Transfer to general fund	\$ 1,796 54
Transfer to sinking fund	10,621 32
	<hr/>
Total.....	\$12,417 86
	<hr/>
Water assessments, 1906, unpaid.....\$	107 73
Water assessments, 1907	47,675 63
	<hr/>
Total water assessments.....	\$47,783 36
Cash receipts from water assessments..	\$47,358 52
Water assessments unpaid	\$ 424 84
Material and labor charges, 1906, unpaid.\$	904 86
Material and labor charges, 1907.....	2,863 18
	<hr/>
Total material and labor charges.\$	3,768 04
Cash receipts from material and labor..	\$ 2,663 97
Material and labor charges unpaid....	\$ 1,104 07
	<hr/>
Total charges	\$51,551 40
	<hr/>
Total cash receipts	\$50,022 49
	<hr/>
Total unpaid bills	\$ 1,528 91

WATER PUMPED.

1907.	Gallons.
January	27,542,700
February	26,736,850
March	38,619,650
April	29,608,225
May	32,081,875
June	31,475,925
July	33,910,675
August	36,762,425
September	31,175,175
October	35,600,375
November	28,929,700
December	28,542,425
<hr/>	
Total, 1907	380,986,000
Total, 1906	368,257,775
<hr/>	
Increase in 1907.....	12,728,225
Daily average in 1907.....	1,043,797
Daily average in 1906.....	1,008,925

The increase occurred during the month of March, when eighty-seven takers were permitted to run a flow of water to prevent freezing. From this an idea may be formed as to what our pumpage would be, if waste was not restricted by meters.

SERVICES.

Seventy-seven services have been laid of the following sizes:

Sixty-three	$\frac{1}{2}$ inch.
Eight	$\frac{3}{4}$ "
Three	1 "
Two	2 "
One	6 "

Ten of the above named replace old services, which have been discontinued, viz.:

No. 16 North Champlain street, 10 Charles street, 8 Chase street, 457 Main street, 191 Pearl street, 72 Pine street, 60 Pitkin street, 167 South Union street, 10 and 14 North Winooski avenue.

Thirty-two services exposed by change of grade, or other cause, have been lowered below the frost line, viz.:

No. 39 Allen street, 67 and 71 Archibald street, 170 Elmwood avenue, 5 Grant street, 146 and 150 Interval avenue, 19 Murray street, 280, 289, 291, 294, 298, 300, 304, 315, 316, 317, 320, 340, 348 and 360 North Bend street, 128 Park street, 67 Peru street, 84 and rear of 83 Pine street, 81 Pitkin street, 5, 13, 23 and 23a St. Louis street.

All of the 124 services reported frozen on the streets in 1904 have now been lowered.

The department responded to 755 calls to open or shut the stops at the curb.

The method of placing our stops within one foot of the curb, and keeping the exact location on record at the office, enables our employees to find them promptly.

FIRE HYDRANTS.

Seven new public hydrants have been set:

One on Brookes avenue, half way between Prospect and Willard streets.

One on Battery street, corner Pearl street.

One on Battery street, corner College street.

One on Clymer street, corner Shelburne street.

One on Greene street, corner Pearl street.

One on Loomis street, corner Greene street.

One on Weston street, corner Loomis street.

Number of public hydrants.....	188
--------------------------------	-----

Number of private hydrants	37
----------------------------------	----

Total number of hydrants.....	225
-------------------------------	-----

Careful inspections are made regularly, and repairs effected within the shortest possible time. We honestly believe that no water department takes better care of its hydrants than we do.

SUPPLY PIPE.

Galvanized iron pipe has been laid on the following streets.

2" on Charles street, between Russell and Willard Sts.	241 feet.
--	-----------

2" on Main street, west of Prospect street.....	255 "
---	-------

2" on Adsit Terrace, east of Willard street.....	277 "
--	-------

Total length of supply pipe now in use.....	26,181 "
---	----------

MAINS.

New mains have been laid as follows:

With six inch cast iron pipe.—

St. Louis street northerly from dead end to Oak street.....	523 feet.
South Winooski avenue below Spruce street, southerly from dead end	400 "
Clymer street, east of Shelburne street.....	36 "

Total length of new mains..... 959 "

Cement and cast iron have been replaced in these streets:

With six inch cast iron pipe.—

North Bend street, between Spring and Oak streets.....	791 feet.
St. Louis street, from Archibald street northerly to dead end	268 "

Replaced in 1907.....1,059 "

Replaced in 1905. (Noted here because it does not appear in the report of 1905):

Blodgett from North to Strong street, and Strong street from Blodgett street to North avenue.....	1,005 feet.
--	-------------

Total replaced.....2,064 "

LENGTH OF PIPE NOW IN USE.

Cement	20,181 feet—about 3.8 miles
Cast iron	191,221 feet—about 36.2 miles
Total.....	211,402 feet—about 40 miles

The erection of the filtering plant at the lake necessitated the removal and replacing of 243 feet of 6 inch cast iron pipe.

A large section of the six inch main pipe in Interval avenue north of Archibald street has been lowered below the frost line. Main pipes are systematically laid within six feet of the curb line, gates placed at the street line. The large map of the city showing the size and location of the water mains and large services prepared in the year 1896, has been brought up to date.

GATES.

The following gates have been discontinued:

North avenue at Battery place.....	1	4-inch.
St. Louis street at north line of Archibald street.....	1	4 "
		—
Total discontinued	2	

Gates have been set in the following locations:

Clymer street, at east line of Shelburne street.....	1	6-inch.
North Bend street, at Oak street.....	1	6 "
St. Louis street, at south line of Oak street.....	1	6 "
St. Louis street, at north line of Archibald street.....	1	6 "
		—
Total added	4	
Total now in use.....	681	

SMALL STOP GATES.

Five small stop gates have been added:

One in Adsit Terrace, at east line of Willard street.	
One in Charles street, at west line of Willard street.	
One in Charles street, at Russell street.	
One to serve as a blow-off at the dead end of the Interval road supply pipe.	
One on Main street, at west line of Prospect street.	
Total number of small stop gates now in use.....	75

REPAIRS.

On cement pipe	3	bursts
On cement pipe	2	leaks
On cement pipe	2	pick holes
On iron pipe	9	joint leaks
On iron pipe	1	plug leak
On services	19	leaks
On services	32	frozen
On hydrants	5	
On gates	3	

SINKING FUND.

Deposits to this fund have been made with the City Treasurer, as follows:

August 13, 1906, 5 per cent. required by charter...	\$ 2,255 57
August 8, 1907, 5 per cent. required by charter....	2,278 10
December 31, 1906, surplus funds	12,418 90
December 31, 1907, surplus funds.....	10,621 32
Total	\$27,573 89

HIGH SERVICE.

The consumption on the high service as indicated by the pumping records of that station, was nearly 15% million gallons, or about 4 per cent. of that of the low service. Of this amount, about 71 per cent. was measured to consumers through meters; 5 per cent. was the estimated loss in the motor; 13½ per cent. was used at the motor valves; about 8½ per cent. returned to the reservoir by way of the overflow pipe; 2 per cent. remains unaccounted for.

About 95½ per cent. of the pumpage was accomplished by the automatic machine, operated by down town consumption, and the remaining 4½ per cent. by the auxiliary steam pump.

Average daily consumption 5,755 cubic ft.

Average daily consumption per tap..... 70 cubic ft.

METERS.

There are now in use 3,109 meters, an increase of 126 over last year. In size they range from ¾ to 3 inches, and are mostly of the displacement type, insuring actual and accurate measurement. Current meters are used on elevator service only. Not a meter goes into service unless it has been tested at our benches and found to be within 3 per cent. of the standard. Consumers enjoy the privilege of seeing their meters tested and without expense at any time.

Readings are taken and careful inspections made every six weeks, or oftener, in order to reduce loss by waste to a negligible minimum. All meters are cleaned and repaired every seven years, or oftener, if necessary. During the year 653 meters of various sizes were cleaned and repaired. All this work was done by our regular employees.

To render the best possible service at a reasonable cost has been the principal aim.

Of the water pumped, about 58 per cent. has passed through meters, about 86 per cent. of the revenue. Since no charge is made for water used for fire purposes only, meters have not been placed in fire services, thus removing any and all possibility of obstruction and stoppage. A meter in a "by pass," however, enables us to detect any illegitimate use of water.

In conclusion, I should like to draw your attention to a few facts:

First—The apparent low cost of the laying of six-inch and other mains on the different streets, enumerated under the head of Construction, is explained by the fact that the pipe was bought and paid for in about the year 1903, and appears in the report of that year.

Second—We have increased the size and also lowered the main on North Bend, caused by the changing of the grade and setting of hydrants. We have lowered thirty-two services occasioned by the freezing up of same.

Third—You will also notice under head of Construction, hydrants and setting, \$979. These hydrants were ordered by the Board of Aldermen to be placed in 1906, and should have gone in that year.

Fourth—In August, we employed Mr. Cashman, the breakwater diver, to shut off the valve at the end of the intake (and also clean the large copper strainer) that we might test the same, which was done with good satisfaction.

Fifth—Kindly notice under head of "Pumping, Buildings and Grounds," \$428.84. This work was caused by the general dilapidation of the roofs, fence, car and track. We have done permanent or construction work to the extent of \$7,087.97. We pump an average of about ten hours per day, including Sunday. The coal consumption and the general efficiency of the boilers and pumps have been compared with other cities and have been found to be above the average.

Respectfully submitted,

J. FRANK KIDDER,

Superintendent.

SUMMARY OF STATISTICS

For the Year Ending December 31, 1907,

IN FORM RECOMMENDED BY THE

NEW ENGLAND WATER WORKS
ASSOCIATION.

Burlington City Water Works.
Burlington, Chittenden County, Vermont.

GENERAL STATISTICS.

Population by census of 1900, 18,640.

Date of construction, 1867-8.

By whom owned, City.

Source of supply, Lake Champlain.

Mode of supply (whether gravity or pumping), pumping.

PUMPING STATISTICS.

1. Builders of pumping machinery, H. R. Worthington.
2. Description of fuel used.

a. Kind, bituminous.
b. Brand of coal.
c. Average price of coal per gross ton, delivered, \$3.75.
d. Percentage of ash.
e. Wood, price per cord, none used.
3. Coal consumed for the year, 2,776,500 pounds.
4. (Pounds of wood consumed) \div 3 = equivalent amount of coal.
- 4a. Amount of other fuel used, none.
5. Total equivalent coal consumed for the year = 3 \div (4), 2,776,500 pounds.

6. Total pumpage for the year, 380,986,000 gallons, with no allowance for slip.
7. Average static head against which pumps work, 289 feet.
8. Average dynamic head against which pumps work, 316 feet.
9. Number of gallons pumped per pound of equivalent coal (5), 137.22 gallons.

$$380,986,000 (6) \times 8.34 \times 100 \times 316 (8)$$
10. Duty = $\frac{2,776,500 (5)}{\text{Cost of pumping figured on low pumping station expenses, viz.: } \$8,965.10.}$ = 36,163,002.
11. Per million gallons raised against dynamic head, into reservoir, \$23.53.
12. Per million gallons raised one foot (dynamic), \$0.074.
 Cost of pumping figured on total maintenance, \$28,234.41.

FINANCIAL STATEMENT.

RECEIPTS.		EXPENDITURES.	
Balance brought forward:		Water works maintenance:	
(a) From ordinary (main-		AA. Operation (management	
tenance) receipts,	\$47,358 52	and repairs).	
(b) Material and labor,	2,663 97	BB. Special.	
Total,	\$50,022 49	CC. Total maintenance,	\$28,234 41
From water rates:		DD. Interest on bonds,	7,520 00
A. Fixture rates,	\$ 6,249 08	EE. Payment of bonds.	
B. Meter rates,	41,109 44	FF. Sinking fund,	12,899 42
		Water works construction:	
C. Total from consumers,	\$47,358 52	GG. Extension of mains.	
D. For hydrants,	3,620 00	HH. Extension of services.	
E. Fountains and parks,	103 47	II. Extension of meters,	3,762 48
F. For street watering,	1,640 24	JJ. Special.	
G. For public buildings,	1,177 38	KK. Total construction,	7,092 12
H. For miscellaneous uses,	300 00	LL. Unclassified expenses.	
I. General appropriation.		MM. Balance.	
J. Total from mun. debts.		(aa) Ordinary.	
K. From tax levy.		(bb) Extraordinary.	
L. From bond issue.		Total balance.	
M. From other sources,	2,663 97		
N. Total,		N. Total.	

Disposition of balance:—

O. Net cost of works to date.....	\$489,538 71
P. Bonded debt at date	188,000 00
Q. Value of sinking fund at date	27,573 89
R. Average rate of interest.....	4 per cent

STATISTICS OF CONSUMPTION OF WATER.

1. Estimated total population at date.....	21,000
2. Estimated population on lines of pipe.....	20,600
3. Estimated population supplied	20,500
4. Total consumption for the year.....	380,986,000
5. Passed through meters	219,610,215
6. Percentage of consumption metered	58 per cent.
7. Average daily consumption	1,043,797
8. Gallons per day to each inhabitant.....	50 gallons
9. Gallons per day to each consumer.....	51 gallons
10. Gallons per day to each tap.....	256 gallons

STATISTICS RELATING TO DISTRIBUTION SYSTEM.

MAINS.	SERVICES.
1. Kind of pipe, cement lined, cast iron, wrought iron.	16. Kind of pipe, galvanized, cast iron and lead.
2. Sizes, from 4 to 30 inch.	17. Sizes, $\frac{1}{2}$ to 6 inches.
3. Extended 959 feet during the year.	18. Extended, 2,156 feet.
4. Discontinued 0 feet during year.	19. Discontinued, 280 feet.
5. Total now in use, 40 miles.	20. Total now in use, 20.27 miles.
6. Cost of repairs per mile, \$—.	21. Number of service taps added during the year, 67.
7. Number of leaks per mile, —.	22. Number now in use, 3,763.
8. Length of pipes less than 4 inches in diam., 4.9 miles.	23. Average length of service, 28 feet.
9. Number of hydrants added during the year (public and private), 7.	24. Average cost of service for the year, \$12.87.
10. Number hydrants (public and private) now in use, 223.	25. Number of meters added, 126.
11. Number of stop gates added during the year, 4.	26. Number now in use, 3,109.
12. Number of stop gates now in use, 681.	27. Percentage of services metered, 89 per cent
13. Number of stop gates smaller than 4 inch, 75.	28. Percentage of receipts from metered water ($B \div C$), 86 per cent.
14. Number of blow-offs, 15.	29. Number of motors and elevators added, 1.
15. Range of pressure on mains, average 70 to 85 pounds.	30. Number now in use, 42.

STATEMENT OF EXAMINATIONS OF CITY WATER MADE AT THE STATE LABORATORY BY THE STATE
BOARD OF HEALTH.

Number.	Collected.	Examined.	Turbidity.	Sediment.	Color.	PARTS IN 1,000,000.								Nitrogen as Nitrates.	Nitrogen as Nitrites.
						Odor.		Total solids.	AMMONIA.		Chlorine.				
						Cold.	Hot.		Free.	Albuminoid.					
45207	12-31-06	12-31-06	*	*	8	20	20	.010	.142	1.0	.200	.000			
45681	1-15-07	1-15-07	*	*	15	0	0	.010	.102	1.2	.210	.000			
45996	1-26-07	1-20-07	*	*	15	0	0	.006	.122	1.1	.210	.000			
46402	2- 2-07	2- 2-07	†	†	20	0	0	.024	.120	1.2	.240	.000			
56357	2- 8-07	2- 8-07	*	*	13	0	0	.022	.136	1.2	.180	.000			
46734	2-25-07	2-25-07	†	†	15	0	0	.016	.104	1.2	.300	.000			
46282	3- 4-07	3- 4-07	†	*	15	0	0	.006	.120	1.2	.250	.000			
47562	3-25-07	3-25-07	*	*	14	0	0	.016	.170	1.2	.200	.000			
50337	7-25-07	7-25-07	*	*	14	0	—	.006	.128	1.1	.300	.000			
50574	8- 1-07	8- 1-07	†	†	10	0	0	.018	.152	1.1	.200	.000			
50088	8-22-07	8-22-07	†	†	20	0	0	.028	.112	1.2	.200	.000			
51498	9-10-07	9-10-07	†	†	16	2†	2†	.024	.162	1.2	.150	.000			
51795	9-25-07	9-25-07	†	†	15	2†	2†	.018	.128	1.0	.120	.000			
52274	10-17-07	10-19-07	*	*	10	0	0	.024	.144	1.0	.170	.000			
52930	11-15-07	11-15-07	*	*	15	2†	2†	.036	.138	1.2	.330	.000			
53195	11-27-07	11-27-07	*	*	15	0	0	.032	.136	1.1	.200	.000			

*Very slight. †None. ‡Distinct. §Slight.

EXAMINATIONS OF CITY WATER—Continued.

SOURCE.	BACTERIA.				REMARKS.
	Bacteria, room temp. in one c.c.	B. coll.	Bacteria per c.c., blood temp.	Ratio of liquidifying to non-liquidifying colonies.	
Tap in Laboratory	300	Absent	80	50%	Usual condition : chlorine too high.
"	300	Present	10	....	Shows evidence of pollution.
"	350	Present	..	....	Chlorine high as usual with presence of colon bacillus.
"	200	Absent	40	....	Usual condition : chlorine above normal for locality.
"	240	Present	80	Liquidified	Shows contamination.
"	700	Absent	4	....	Polluted water.
"	600	Absent	12	....	High chlorine.
"	120	Absent	4	....	Usual condition : showing contamination and high chlorine.
"	310	Absent	2	Complete	Chlorine above normal.
"	900	Present	190	....	Polluted water.
"	400	Absent	84	....	Usual condition : high chlorine.
"	400	Present	20	....	Polluted.
"	300	Present	60	....	Polluted.
"	400	Absent	50	....	Chlorine above normal.
"	330	Present	60	Complete	Polluted.
"	300	Absent	10	....	Chlorine and ammonia are high.

